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SYMPTOMS PRODUCED BY DISTENTION OF THE GALLBLADDER AND BILIARY DUCTS[1]

A CLINICAL AND EXPERIMENTAL STUDY

BY V. L. SCHRAGER, M.D., AND A. C. IVY, PH.D., M.D., CHICAGO
ASSISTED BY M. KRONENBERG, M.D., AND P. DYSART, B.S.

FOR many years, one of us (Schrager) has observed that certain cases of biliary colic are associated with respiratory embarrassment at the height of an attack. It is our purpose to point out the clinical significance of this phenomenon, and to present a detailed experimental study of the symptoms produced by distention of the gall bladder and biliary passages.

In 1908, Schrager was summoned to the bedside of a young woman, 18 years of age, who 3 days previously had had a normal delivery. She was suddenly seized with a severe upper abdominal pain associated with an unusual respiratory embarrassment, which lasted about 45 minutes, subsided abruptly, and recurred in the same manner twice in the following 5 days. Several weeks thereafter a similar attack occurred. The pain was more definitely localized in the right hypochondrium, radiated to the back, and in other respects assumed a frank picture of gall-stone colic. Since the original observation, Schrager has seen a number of cases of upper abdominal distress associated with respiratory difficulty following delivery, especially in young primiparæ. Several of these cases came to the operating table and, it was observed that the degree of respiratory difficulty depended upon the degree of distention of the gall-bladder wall, or the mechanical obstruction of the cystic duct. Several cases of hydrops of the gall bladder markedly exhibited this respiratory phenomenon. This was found to be especially true when the cystic duct was blocked by a large stone.

A very striking case was that of a woman, 49 years of age, who was suddenly taken ill with a very severe pain over the base of the right lung, which was associated with respiratory embarrassment. A physician, related to the patient, saw her several times within 48 hours and made a diagnosis of acute pleurisy. Strapping of the chest, salicylates, and opiates gave the patient no relief. Questioning of the patient disclosed the information that, for the past 25 years, she had had similar attacks associated with pain in the right hypochondrium. Physical examination revealed a very marked tenderness below the right costal arch associated with marked resistance to pressure. Because of previous experiences, Schrager was not confused by the respiratory phenomenon and location of the pain over the base of the right lung, and diagnosed the condition as due to a distended gall bladder. Operation revealed an extreme hydrops of the gall bladder; the organ was distended to the breaking point, and contained a clear mucoid fluid. The cystic duct was impacted with a date-like stone which was forced out with difficulty even after the removal of the gall bladder.

As time went on Schrager learned to ascribe definite significance to the respiratory embarrassment associated with upper abdominal colic, and quite uniformly found it to mean

[1]From the Departments of Physiology and Surgery, Northwestern University Medical School, with clinical observations made at the Mt. Sinai and Frances Willard Hospitals, Chicago

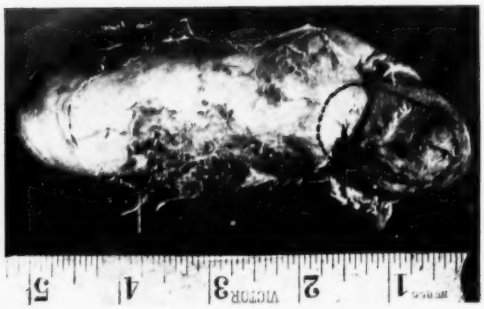

Fig. 1. Photograph of a hydrops of the gall bladder in a case in which the conspicuous symptom was difficulty in breathing. The dotted line indicates size and location of the stone.

gall-bladder distention with or without impaction of the cystic duct. In a limited number of cases the pain instead of radiating toward the back and shoulder is referred to the midsternum. In people, aged about 50 or more, this clinical complex may suggest angina pectoris. The anginal picture associated with gall-bladder pathology is at times confusing, and able clinicians have to weigh the evidence very carefully before arriving at a final diagnosis. This differentiation becomes more difficult when there are actual organic heart changes associated with chronic gall-bladder pathology. The reaction of the cardiovascular system to gall-bladder pathology, we believe, depends upon the latent condition of the heart at the time the gall-bladder stimulus is set in action.

An illustrative case is that of a man, 55 years old, who was seized with upper abdominal pain referred to the sternum and precordium and accompanied by sweats and moderate collapse. The patient's son, a young physician, had made a diagnosis of angina pectoris, and was surprised when Schrager made a diagnosis of hydrops of the gall bladder. Subsequently, roentgenological evidence of a single large stone was obtained.

Consulting the literature, we found very few allusions to the symptom of respiratory embarrassment in gall-bladder disease. Llewellyn Sale (9) takes much for granted when he states: "Limitation of diaphragm movement in the presence of certain intra-abdominal lesions is well known." There is a casual mention of the respiratory phenomenón by Moynihan, Choyce, and A. B. Johnson. Moynihan, describing a typical biliary attack, states that the breathing is difficult because of "spasm of the diaphragm, which like other abdominal muscles is tightly contracted to form that firm muscular splint, the purpose of which is to keep at rest and free from harm the region in need of protection." Choyce speaks of the "catching of breath" in the more severe varieties of gall-stone colic.

Bodenstab (1), analyzing a series of 500 cases of gall stones operated upon either by Quaine or Ramsted, found that dyspnœa was present in 243 cases. He ascribed this phenomenon to a spasm of the diaphragm which limits its excursion and causes shortness of breath. The latter symptom has often been mistaken for pleurisy or pneumonia.

Crile, in the chapter on surgical physiology in Keen's *System of Surgery* (2), writes: "The reflex phenomena in gall-stone colic from a diagnostic standpoint are most interesting. There is scarcely a subjective symptom so important as the inhibition of the diaphragm in gall-stone colic. The inhibitory paths through afferent nerves supplying the gall-bladder region which are located in adjoining segments of the spinal cord to that of the phrenics to which this impulse is transferred is an explanation of this important phenomenon. Almost every case of gall-bladder or gall-stone colic if questioned, will give a history of inhibition of the diaphragm during the attack. The diagnostic importance of this symptom is increased greatly by the fact that such inhibition occurs in almost no other instance." In a personal communication Crile states: "I can confirm what you have said concerning respiratory phenomena accompanying obstruction of the cystic duct. This symptom is routinely sought for in my clinic at the Lakeside Hospital."

Llewellyn Sale, in a paper before the section of practice of medicine at the sixty-seventh annual session of the American Medical Association held in Chicago in June, 1918, discussed the subject of diaphragmatic contractions associated with acute abdominal conditions, especially appendicitis. His control examinations on soldiers in good health and without either thoracic or abdominal symp-

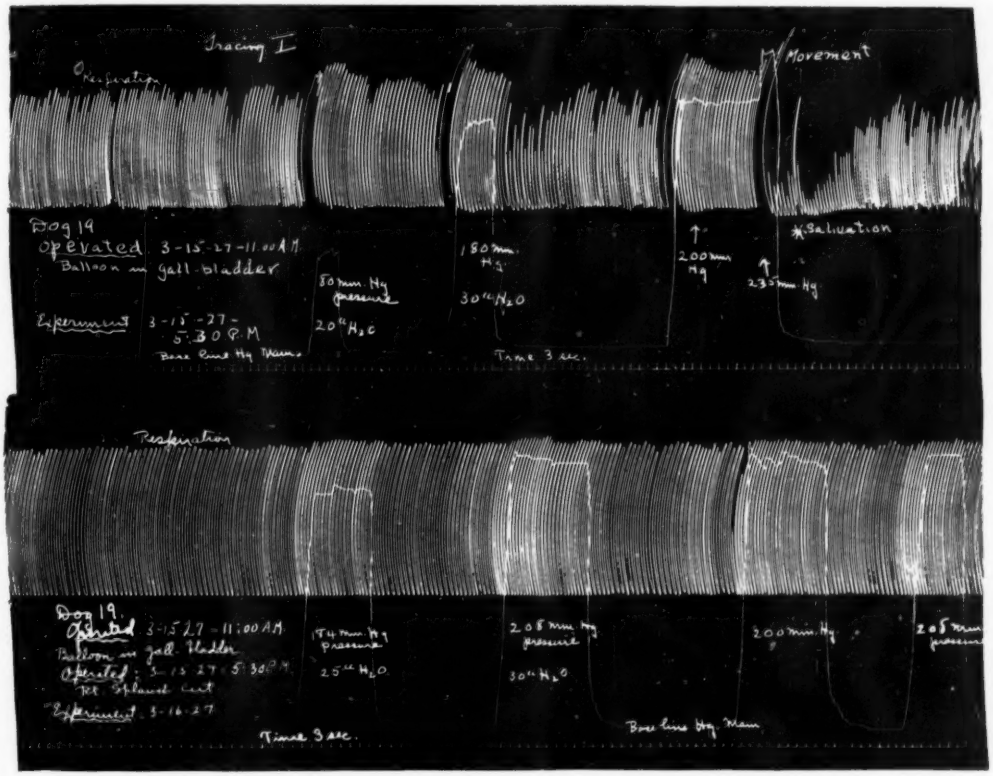

Fig. 2. In this experiment a balloon was placed in the gall bladder. The upper tracing of this figure shows the effect of distending the gall bladder on respiration. Note the inhibition of respiration and the salivation. After the upper tracing was made, the right splanchnic nerve was cut. Distention of the gall bladder then caused no symptoms. In some cases, after section of the right splanchnic, we observed some inhibition of respiration and some nausea. Salivation denotes nausea.

toms showed no difference in the excursion of the two halves of the diaphragm; occasionally, there was slightly greater excursion on the right side. Diaphragmatic limitation was observed by Sale not only in cases in which the corresponding peritoneal surface of the diaphragm was involved, but also in cases in which the pathological lesion was distant. Sale's observations are original and interesting. Similar observations were made by Hubeny (4), who found diaphragmatic limitation in a case of gastric ulcer at the œsophageal junction. He speaks of unilateral "peculiar fluffing of the diaphragmatic arcs" in abdominal disease and concludes that "should these fluffings be present, pathology of some kind should be suspected." Hughes (5) found cessation of function of the diaphragm on the corresponding side of the abdominal lesion if the peritoneal surface was irritated by an inflammatory process.

The acceptance of the inhibitory reflex, obvious to the afore-mentioned observers, is not quite clear physiologically as the phrenic nerve has no known inhibitory fibers, "unless it is due to an inhibition of the motor phrenic center in the cord" (Sale). In a discussion of Sale's paper, J. Birney Guthrie, of New Orleans, alludes to the diaphragmatic sign as Williams' sign. He compares the splinting of the diaphragm, in neighboring pathology, to the splinting of muscles in chest diseases,

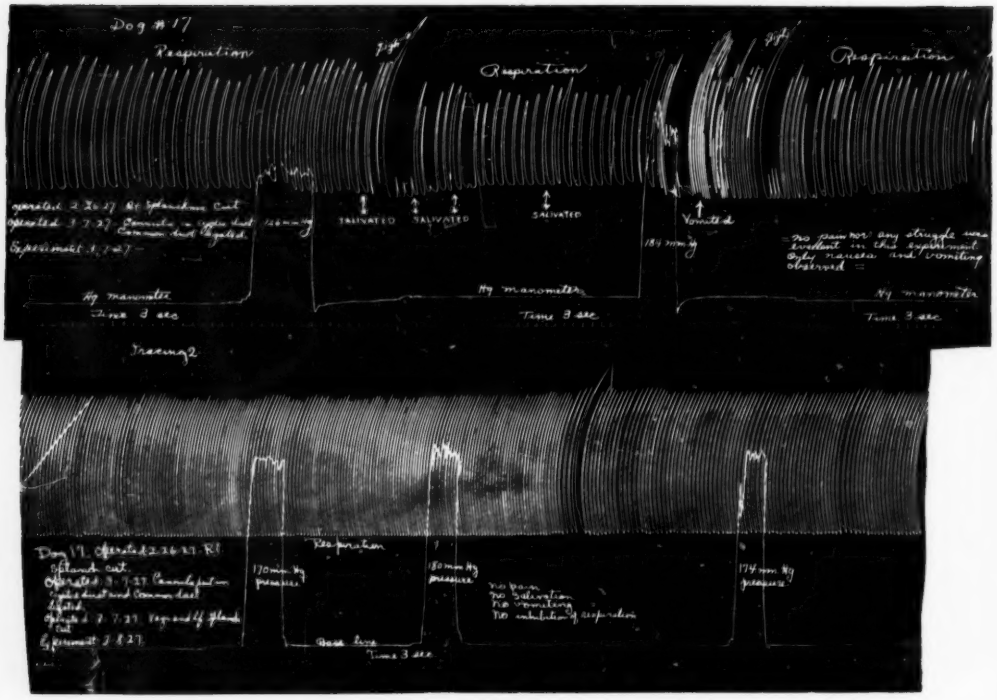

Fig . 3. The right splanchnic nerve of this dog was cut on February 26, 1927. On March 7, the common bile duct was doubly ligated and the cystic duct cannulated. The upper tracing shows the effect of distention of the biliary passages with the right splanchnic cut. No pain was elicited, but some change in respiration was noted as well as salivation (nausea) and vomiting. The lower tracing shows abolition of all symptoms following section of the vagi and left splanchnic nerves.

such as Litten's sign, or the fixation of muscles around joint diseases, or the wasting of thoracic muscles in pulmonary tuberculosis.

Pottenger (8), in the same discussion, classifies the diaphragmatic sign as viscerogenetic reflex. He states: "I do not believe that we can explain this reflex through the phrenic nerve. It must be through the lower intercostals. The phrenics take their origin from the third and fourth cervical segments of the cord, and are in reflex communication with afferent impulses which come from the lung. The abdominal viscera, however, are supplied by the sympathetic nerves, which take their origin from the lower 6 thoracic segments of the cord. Afferent sensory impulses, traveling centralward from the abdominal viscera, transmit their impulses to the 6 lower intercostal nerves, which supply the intercostal muscles, the central portion of the diaphragm, and the abdominal muscles." Professor Erlanger likens the diaphragmatic inhibition to that of the abdominal muscles in the vicinity of acute inflammatory processes. In a personal communication, Sale accepts the possibility of voluntary inhibition of one-half of the diaphragm. The paper of Sale and the discussion thereof are quoted extensively, as they constitute the most elaborate document we have been able to find in the literature in support of the phenomenon of diaphragmatic inhibition.

On the whole the diagnosis of the pathologic gall bladder has become as obvious as that of appendicitis, especially since the introduction of the Graham-Cole test. However, we still meet with disappointments and surprises, and large group clinics, with excellent clinical

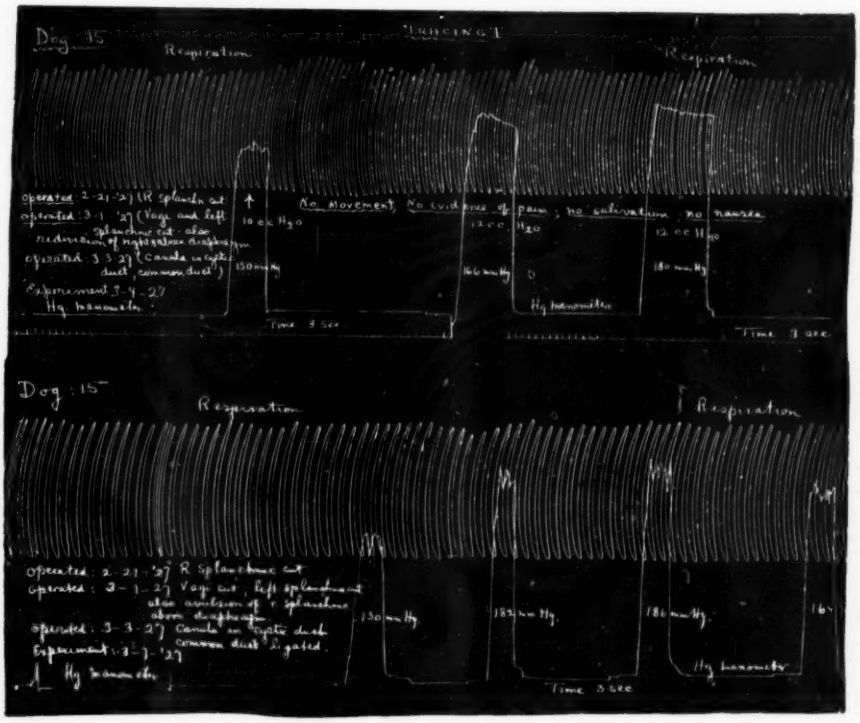

Fig. 4. The right splanchnic nerve of this dog was cut on February 21, 1927, and the vagi and left splanchnic nerves were cut on March 1. On March 3, the common bile duct was doubly ligated and the cystic duct cannulated. Distention caused no symptoms.

and laboratory facilities, not infrequently miss or "mis-diagnose" pathology of the gall bladder. The presence of respiratory embarrassment associated with an upper abdominal complex has been a valuable aid in the diagnosis of pathologic gall bladder and cystic ducts, and has seldom deceived us. It is rather strange that medical literature, so prolific on all phases of the subject, should be totally silent on the subject.

The scarcity of data concerning this symptom prompted us to undertake physiological experiments.

PHYSIOLOGICAL ASPECT

Because of the clinical relationship between disease of the biliary passages and the respiratory mechanism, noted by one of us (Schrager), we were stimulated not only to study the effect of distention of the gall bladder and biliary passages on respiration, but also to study the course taken by sensations produced by distention which result in objective symptoms, namely, inhibition of respiration, distress, nausea, and vomiting, and to observe the occurrence of other concomitant phenomena.

METHODS

In the experiments in which the effects of distending the gall bladder were studied, a toy balloon, attached to a hard rubber tube was placed in the gall bladder through an incision in its dome. By a T-tube, the tube coming from the balloon could be connected with a mercury manometer for recording pressure. The balloon was distended with water at 39 or 40 degrees centigrade, a 50-cubic centimeter syringe being used so that the amount of water used could be measured.

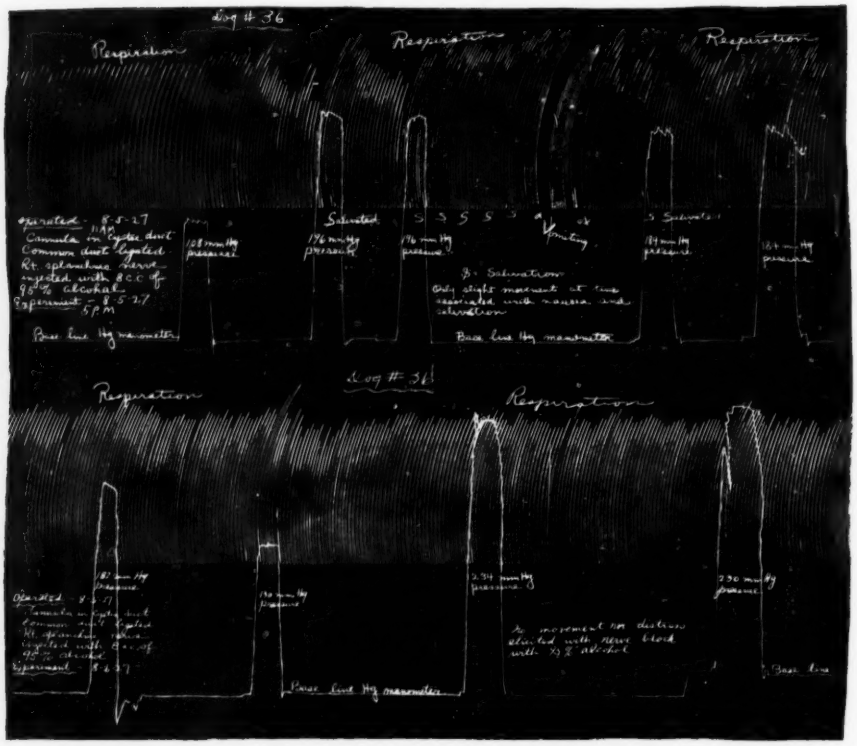

Fig. 5. This animal was prepared for biliary-duct distention and at the same operation the right splanchnic nerve was infiltrated with 8 cubic centimeters of 95 per cent alcohol under direct vision. The tracings show that the alcohol blocked the nerve and gave the same results as mechanical section. The salivation (nausea), vomiting, and slight change in respiration in the upper tracing were due to the fact that the vagi were still intact.

In the experiments in which the effects of distention of the cystic duct and biliary passages were studied, a cannula was inserted into the cystic duct via the gall bladder and tied in place with linen thread. The common bile duct was doubly ligated.

The vagi and left splanchnic nerves were sectioned just above the diaphragm through an incision between the fifth and sixth ribs on the left side. Care was taken to section all of the branches. The left sympathetic chain was avulsed down to the point where it passed under the diaphragm.

The right splanchnic was cut through a right kidney incision just as it passes under and below the diaphragm. From two to three other small branches of the right sympathetic chain given off just below the diaphragm were also sectioned.

In the experiments in which blood pressure was taken, the carotid artery was brought to the exterior by a simple operation prior to or at the same time that the cystic duct was cannulated. Only ether anæsthesia was used. Strict aseptic precautions were taken in the operative procedure.

Our experiments were performed only after the animal had fully recovered from the anæsthetic, i. e., from 6 to 24 hours after the operation, each experiment on the same animal being repeated from 4 to 10 times during a period of from 2 days to a week. Respiration was recorded by a pneumograph tracing. Autopsy was performed on every dog.

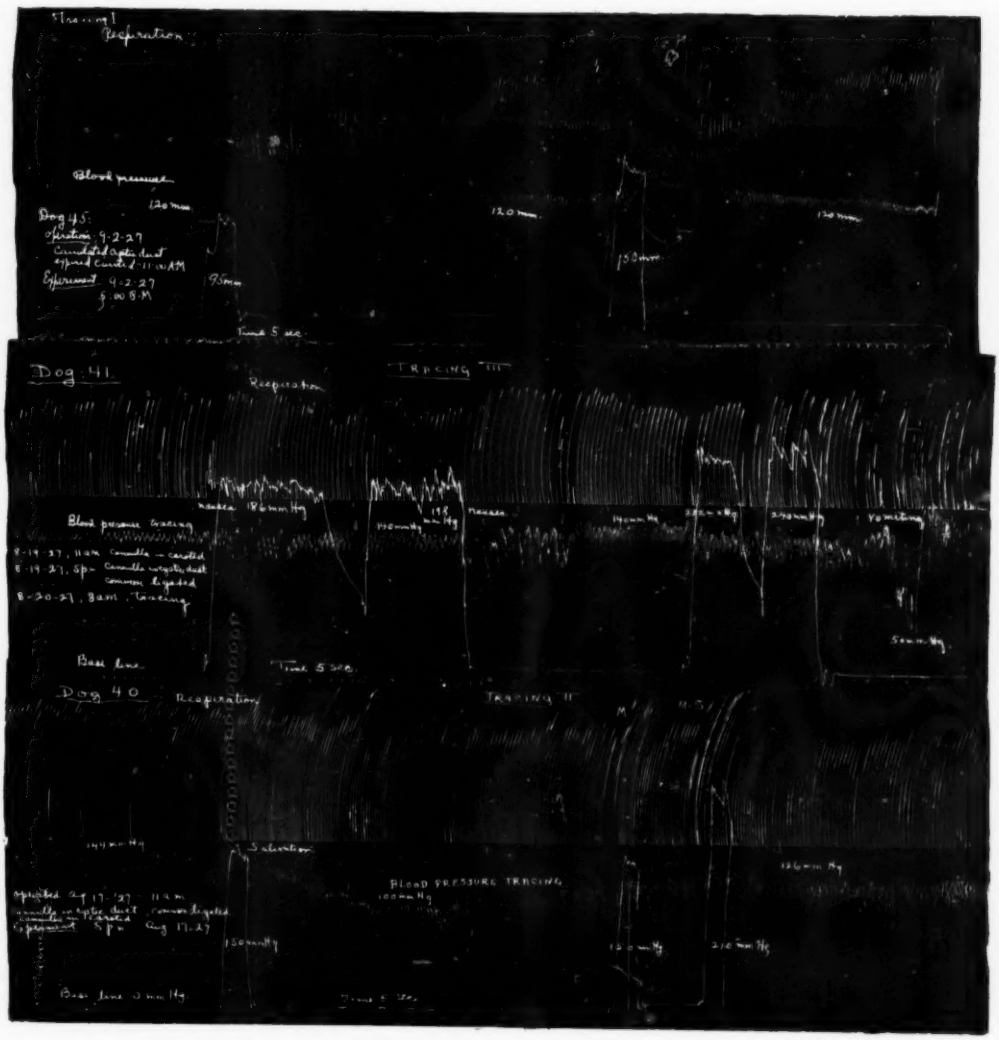

Fig. 6. This figure shows simultaneous blood pressure and respiratory tracing from 3 animals on distention of the biliary ducts. The response varied in each animal. On the right of the middle tracing can be seen the effect of vomiting on blood pressure.

RESULTS

Distention of the gall bladder. In these experiments we looked especially for the following reflex manifestations: (1) distress, (2) inhibition of respiration, (3) salivation, which denotes nausea in the dog, and (4) vomiting.

The gall bladder was distended in 22 dogs. Of these, 2 had the vagi and left splanchnic cut, 4 had the right splanchnic cut, and 4 had both vagi and splanchnics cut. We generalize in this manner because it is impossible to publish all of our data relative to these experiments.

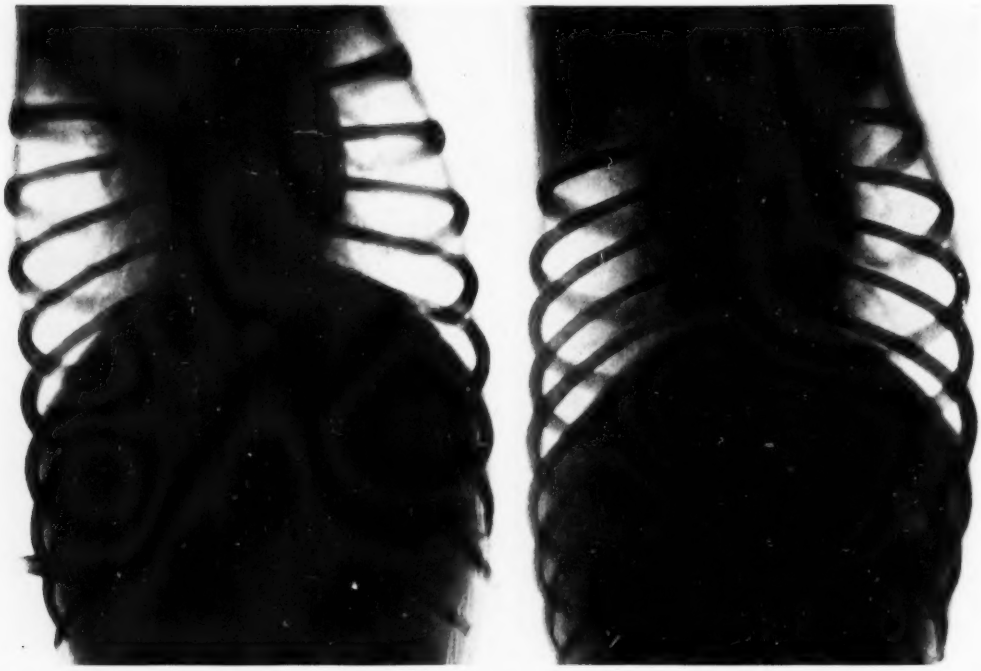

Fig. 7. This figure shows the effect of biliary-duct distention on the position of the diaphragm. The roentgenogram on the left is the control at the depth of inspiration and on the right is during distention of the biliary ducts. Note that the right side of the diaphragm is at a lower level than the left side and is somewhat less circular or "domed" during distention. We believe that this denotes "splinting."

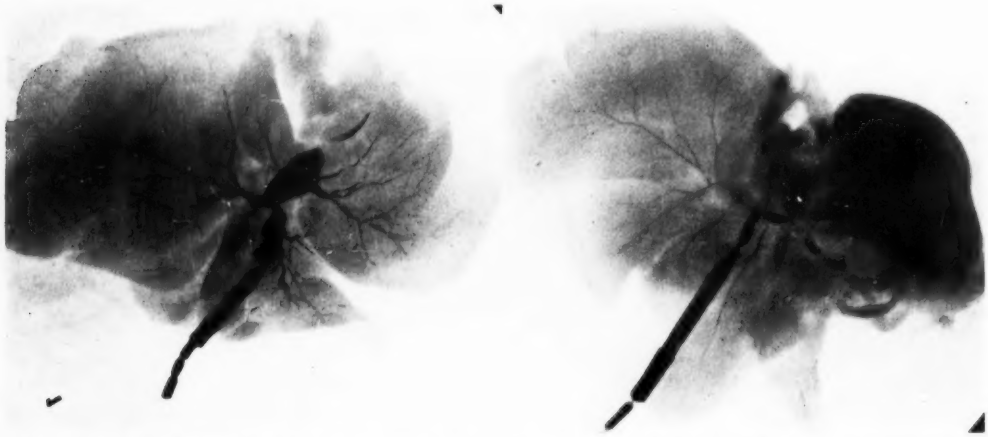

Fig. 8. This figure shows the effect of frequent intermittent distention of the biliary ducts on their size. The roentgenogram on the left is from a dog in which the biliary ducts had been distended at intervals for 8 days. The roentgenogram on the right is from a normal dog of approximately the same size and body weight. The opaque material was injected into the ducts under the same pressure.

Our observations on distention of the gall bladder can be summarized as follows: (a) Distention of the gall bladder causes distress, inhibition of respiration, and occasionally, salivation and vomiting. The distress was not marked when compared with the distress caused by distention of the biliary passages. In one dog, marked distention (240 milligrams of mercury) of the gall bladder caused no distress. The inhibition of respiration always occurred, but was more marked in some dogs than in others. It was, in most instances, inspiratory in type. Salivation, denoting nausea, occurred in approximately 40 per cent of the dogs; whereas, vomiting only occurred once and then when food was in the stomach. That vomiting is more readily elicited when the stomach is filled with food or when it is showing hunger contractions has been the observation of one of us (Ivy). (b) Section of the right splanchnic nerve in 3 dogs abolished all reflexes. (c) Section of the vagi and left splanchnic in 4 dogs abolished reflexes for from 24 to 48 hours after which distress occurred on distention. Marked distention with 100 cubic centimeters of water caused distress at all times in these dogs.

The amount of pressure necessary to cause the inhibition of respiration was less than the amount necessary to cause salivation and distress. The minimal pressure required to elicit reflexes varied widely in different dogs, the minimal observed was 40 millimeters of mercury with 30 cubic centimeters of water.

Distention of the cystic and biliary ducts: In these experiments, the water at 39 or 40 degrees centigrade came into contact with the walls of the ducts, since a balloon could not be used. The water was injected through the tube attached to the cannula in the cystic duct, the common bile duct being doubly tied. The ducts were distended in 28 dogs. Of these, 4 had the vagi and left splanchnic cut, 4 had the right splanchnic cut, and 6 had both vagi and splanchnics cut.

Our observations may be summarized as follows: (a) Distention of the biliary ducts causes marked distress, inhibition of respiration, usually inspiratory in type, salivation or nausea always if the pressure is above 100 millimeters of mercury, and frequently vomiting. It was very evident that the symptoms were more severe and uniform when the biliary ducts were distended than when the gall bladder was distended. Symptoms could be elicited with less pressure, the minimum being 20 millimeters of mercury and 7 cubic centimeters of water. (b) Section of the right splanchnic nerve abolished the distress in all experiments and reduced the degree of inhibition of respiration. The amount of change in inhibition of respiration following right splanchnic section varied in different dogs, some dogs showing very little change and others showing a 50 per cent change. (c) Section of the vagi and left splanchnic abolished the salivation and vomiting and reduced the respiratory inhibition in all experiments. The reduction of respiratory inhibition was more marked following vagus section than following right splanchnic section. (d) Section of both vagi and splanchnic nerves abolished all reflexes, unless the distention was very great (over 300 milligrams of mercury).

The effect of drugs on the symptoms produced by distention of the biliary ducts. Procaine instillations. From 10 to 15 cubic centimeters of 2 per cent procaine was injected into the biliary ducts in 4 experiments. In from 5 to 10 minutes after the procaine injection, distention of the ducts elicited no symptoms, except in 1 dog on marked distention (240 milligrams of mercury). The effect of the procaine lasted about 20 minutes. The procaine was absorbed very rapidly from the ducts and 2 of the dogs had mild convulsions and one other muscular twitchings from which they recovered. After instillation of procaine, we observed that from 5 to 10 cubic centimeters more of water was required to produce pressures equivalent to those prior to the instillation, denoting a decrease in tone of the biliary ducts.

Cocaine hydrochloride subcutaneously. One milligram of cocaine hydrochloride per kilogram body weight was injected hypodermically in dogs with the cystic duct cannulated and the common duct doubly ligated. It was found that this dose of cocaine completely abolished the symptoms caused by distention in two animals and definitely amelioriated

the symptoms in the other two. From 10 to 20 minutes were required before the drug became effective. As was the case in procaine instillation, more water was required to produce equivalent pressures after cocaine injection than before.

Morphine-atropine subcutaneously. From 3/8 to 1/2 grain of morphine sulphate and from 1/40 to 1/60 grain of atropine sulphate was injected subcutaneously in from 10 to 12 kilo dogs, whose ducts were prepared for distention. This injection failed to ameliorate the symptoms produced by distention. When the dose of cocaine was added to this dose of morphine-atropine, the symptoms were markedly ameliorated.

Papaverine sulphate. Papaverine sulphate was used in 2 experiments on one dog with only a slight ameliorating effect.

Ether. Moderate ether anæsthesia abolished all symptoms. Under very light ether anæsthesia the inhibition of respiration could be elicited sometimes and at other times not. This is the reason why it was absolutely necessary for us to allow our animals to recover from anæsthesia.

Right splanchnic nerve blocked with procaine. After considerable practice in locating and injecting the right splanchnic nerve in dead dogs, we injected, or infiltrated, the right splanchnic nerve of dogs prepared for biliary-duct distention with 2 per cent procaine solution colored with gentian violet. This was done in order to ascertain whether or not the pain impulses could be blocked by such a procedure. We found that although we were successful in infiltrating the nerve, the distress caused by distention was only partially, and not completely, abolished. In dog 39, the nerve was blocked under direct vision at operation with 2 per cent procaine. One hour later (after the animal had recovered from the anæsthesia), distention caused no distress or inhibition of respiration.

Right splanchnic nerve blocked with 70 per cent alcohol. The experiments on procaine block were repeated using 70 per cent alcohol under direct observation by operative procedure. It was found that the alcohol block completely abolished the distress caused by distention of the biliary ducts, its action being directly comparable to section of the right splanchnic nerve.

The effect of distention of the biliary ducts on blood pressure. Five animals were prepared so that the effect of distention of the bile ducts on the blood pressure could be followed. Thirty-four tests were made on the 5 animals.

Our results show that distention of the bile ducts changes the blood pressure and heart rate. The effect, however, was not uniform, i. e., in some tests the pressure rose; in some it fell; in others it fell and then rose; and in others it became very irregular, rose and fell as much as 50 millimeters of mercury during the period of distention. In dog 40, we observed all of these variations. In the 4 other dogs (41, 42, 44, and 45) the usual response was that the pressure first fell 10 or 20 millimeters for 10 or 20 seconds and then rose 15 or 30 milligrams for from 1/2 to 2 minutes. In 2 dogs, the rate of the heart was increased, in 2 the rate was decreased, and in 1 (dog 40) the rate was sometimes increased and at other times decreased.

In dog 40, distention caused "skipped beats" to appear which persisted for several minutes after the distention. In 1 dog, we transplaced the carotid for a blood pressure tracing prior to the operation on the bile ducts. We did this to determine whether or not the placing of the cannula in the cystic duct and the ligation of the common duct had any effect. The result was negative.

Dilatation of the biliary ducts from continued intermittent distention. In 3 animals in which the cystic duct was cannulated and the common duct tied, and in which the ducts had been distended intermittently for a week, we observed that the ducts were definitely dilated. The ducts were filled with a solution containing bismuth and a roentgenogram was made.

An attempt to study the effect of cholecystitis on the amount of distention required to produce symptoms. It is quite possible that if the gall bladder or ducts were inflamed, less pressure would be required to produce symptoms than in the case of a "normal" gall bladder and ducts, because partial asphyxia and inflammation increases the irritability of nerve endings.

In order to study this aspect, a balloon was placed in the gall bladder and the minimum pressure required to produce inhibition of respiration and distress was determined. Then 8 cubic centimeters per kilogram body weight of Dakin's solution (pH, 9.0; free chlorine 0.48) was injected. Four animals were so prepared and injected. The injection killed all 4 animals within 12 hours.

We are not able to explain these results because we injected 10 normal animals with 10 cubic centimeters of the same solution per kilogram with only 1 death, and have injected 5 cholecystectomized dogs without a death.

We next tried to produce a chemical cholangitis by injecting acid into the biliary ducts. The common duct was ligated and the cystic duct cannulated. After the animals recovered from the anæsthesia 10 cubic centimeters of 0.2 per cent hydrochloric acid was injected into the biliary ducts. No immediate deleterious results were observed; however, the animal died within 12 hours. Marked changes in the liver were noted.

The effect of distention of the biliary ducts on the position of the diaphragm. Since roentgenological evidence in cases of biliary colic in man revealed that the right side of the diaphragm was contracted (at a lower level than the left diaphragm), we conducted experiments in order to determine whether or not such contraction would occur in the dog on distention of the ducts.

The common duct was ligated and the cystic duct cannulated. A roentgenogram was made, then the ducts were distended and during the respiratory arrest another roentgenogram was made. It was found by such an experiment on 4 animals, that the right side of the diaphragm was contracted, assuming the position seen at inspiration and at a lower level than the left side of the diaphragm.

To ascertain whether or not this was due to the presence of the cannula in the duct or to the abdominal operation, we did the following experiment: (1) We made a roentgenogram of the diaphragm at inspiration before the operation; (2) then we made a roentgenogram at inspiration after a simple right rectus incision was made and closed; (3) then we made another at inspiration after the incision was opened and the duct cannulated; (4) and finally, another on distention of the ducts. The results of this experiment revealed that the position of the diaphragm observed in our other experiments was due solely to the distention of the ducts.

Distention of the stomach and jejunum. A dog with a gastric fistula and another with a Thiry fistula of the jejunum were prepared. The rather sudden distention of the stomach with 550 cubic centimeters or more of water caused some inhibition of respiration followed by an increase. It was not as characteristic as the inhibition seen in distention of the biliary passage in that it was not as sudden and not as complete. The same was true of distention of the Thiry fistula of the jejunum.

DISCUSSION

Our results definitely demonstrate that inhibition of respiration on distention of the gall bladder and biliary passages is a definite physiological response. The sensory impulse that causes the effect is carried by the vagi and right splanchnic nerves, chiefly by the former. Less pressure is required to produce this phenomenon when the cystic duct and other biliary ducts are distended than when the gall bladder is distended. It is possible, but not very probable, that the response on distention of the gall bladder is due to distention of the cystic duct, as occurs on the impaction of a stone in the neck of the gall bladder and first part of the duct, because in our gall-bladder experiments the cystic duct was not ligated. We did not ligate the cystic duct because we believed that it was impossible to do this without interfering with the nerve supply of the gall bladder. At any rate, it is quite obvious from our experiments that a respiratory disturbance must be looked for in colic due to gall-bladder or biliary-duct diseases, especially if the colic is due to the impaction of a stone in either the cystic or common bile duct.

The fact that 1 dog failed to manifest distress or disturbance of any kind when the gall bladder was markedly distended is analogous to the clinical observation that the gall bladder of some patients can be markedly

distended with stones, etc., without any symptoms or with only slight symptoms.

The contraction, fixation, or limitation of movement of the right diaphragm observed by us confirms the observations of others. The most obvious explanation of this phenomenon we believe is the one offered by Moynihan, namely, that it serves the purpose of demobilizing or splinting the diseased part.

Our results, observed following section of the splanchnics and vagi, reveal in a clean cut manner the course taken by afferent sensations from the biliary passages. Our observations on the gall bladder are not so clear cut. It is difficult for us to explain adequately why the distress is temporarily affected by section of the vagi. The only explanation that we have to offer is based on the difference of threshold that we have shown to exist between the gall bladder and biliary passages, the threshold of the nerves of the gall bladder being higher (more difficult to excite) than that of the biliary passages. This being the case, it is possible, for purposes of explanation, to assume that the section of the vagi in some unknown manner raises still higher the threshold of the nerves of the gall bladder, and after a day or two, the threshold gradually returning toward the normal, we again obtain distress on distention. It is also necessary to assume that the threshold of the nerves of the biliary passages is so low (easily excited) that section of the vagi, although section of the vagi may have some effect, has no material effect on their threshold or the intensity of the stimulus necessary to stimulate them. Just what rôle the cerebrum plays in the production of the symptoms, we cannot state.

The fact that muscular twitchings and excitement occurred on the injection of procaine into the biliary passages shows that absorption of crystalloids by their mucosa can occur at a rapid rate.

Cocaine was administered subcutaneously because Kast and Meltzer (6) found that visceral pain is abolished by relatively small doses of cocaine subcutaneously, which has been confirmed for the lung by Kleitman (7), and because smooth muscle is first stimulated and then depressed by cocaine as well as procaine. The action of the cocaine on the distress caused by distention was much more definite than any effect of the morphine-atropine mixture, which we believe was nil. Our observations show that the cocaine decreases the tone of the ducts as well as materially decreases the distress resulting from distention. Our observations, we believe, warrant the use of cocaine (not more than 60 milligrams or 1 grain subcutaneously) in severe cases of biliary colic that do not respond to morphine-atropine, provided idiosyncrasy to cocaine is not present in the patient. Our experiments with papaverine were disappointing. However, this drug may prove to be efficacious in biliary colic as it occurs in man.

Our results on blocking the right splanchnic nerve show that adequate methods will produce a block of sensations causing distress due to distention of the biliary passages. In order to obtain complete blocking, the splanchnic nerve had to be injected under direct vision. When the procaine was injected without direct visualization of the nerve, only partial effects were obtained, probably because a sufficient amount of procaine did not come into direct contact with the nerve.

Our results on abolishing pain from the biliary passages by section or adequate "blocking" of the right splanchnic nerve in dogs confirm the findings in man of Kocher, Kaffis, Kulenkampff, which have been reviewed and confirmed by De Takats (3). It is not to be concluded from our observations, however, that pain sensations from other viscera are carried solely by the right splanchnic nerve.

Our observations on the effect of distention of the biliary passages on blood pressure and heart rate show that sensation from the biliary passages has no specific effect on the cardiovascular system. The cardiovascular system is affected, but not in a specific manner. We had expected to observe a fall in pressure and a decrease in heart rate from reflex stimulation of the depressor and vago-inhibitory centers in the medulla. The variation in response that occurred can be best explained by assuming that the character of the response depends entirely on the condition of the cardiovascular system at the time

the biliary passages are distended. The fact that "skipped beats" occurred in 1 dog supports this explanation. Electrocardiograms were made in 2 dogs before, during, and after biliary-duct distention with negative results.

It might be objected that the pressures required to produce symptoms in our dogs are too great to be of any significance. In this connection it should be pointed out that the pressures we recorded were for the most part only approximately correct, and that the inflamed gall bladder and biliary passages are quite probably more sensitive than the normal, since it is well known that inflammation generally increases the irritability of nerve endings.

SUMMARY

It has been observed clinically that patients with distended gall bladder or with stone impacted in the cystic duct suffer from respiratory embarrassment during an attack of colic. This symptom has been of much value in the differential diagnosis of diseases of the gall bladder and biliary ducts, because it is either absent or not significantly present in any other abdominal complex.

Physiological experiments have demonstrated that distention of the gall bladder and biliary ducts causes inhibition of respiration, chiefly inspiratory in type. Distention also produces other symptoms such as nausea, vomiting, and distress, in proportion to the degree of distention of the biliary passages. Distention of the biliary ducts causes more striking symptoms than distention of the gall bladder alone.

It has been observed that nausea, vomiting, and some of the respiratory inhibition are abolished by section of the vagi and that distress and some respiratory inhibition are likewise abolished by section of the right splanchnic.

Instillation of cocaine or procaine into the bile ducts temporarily abolishes or ameliorates the symptoms caused by distention; this is also true in a case of subcutaneous injection of cocaine.

Blocking of the right splanchnic nerve with procaine or alcohol under direct vision produces results equivalent to right splanchnic section.

Distention of the ducts causes changes in the blood pressure and heart rate, but these changes are not uniform. We believe that the reaction of the cardiovascular system to distention of the biliary passages is dependent upon the functional condition of the cardiovascular system at the time the distention occurs.

It was found that intermittent distention of the biliary ducts over a period of 1 week caused decided dilatation of them. It is further observed that during the respiratory inhibition caused by distention, the right side of the diaphragm was contracted apparently to serve as a splint.

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CARDIOVASCULAR COMPLICATIONS AND THEIR RELATION TO SURGERY[1]

By LEONARD G. ROWNTREE, M.D., Minneapolis, Minnesota
From the Division of Medicine, Mayo Clinic and The Mayo Foundation

THE more I see of the practice of medicine, the more I admire the healing power of Nature; but while my respect for the old time galenicals is diminishing, my respect for judicious surgery is becoming more profound. To me, the lack of adequate correlation between medicine and surgery seems deplorable. We medical men and surgeons are doing our utmost, but too often independently. After all, we can only offer assistance in the natural processes of healing. Our combined resources are often meager enough and should always be pooled for the benefit of the patient. There should be no conflict of interest between medicine and surgery for both are aiming at a common end.

Most diseases are self-limited—cured by Nature and hers are the secrets that we must learn. How does Nature induce a crisis in pneumonia, establish immunity to childhood diseases, cause migraine to disappear in later life, control infection, stop hæmorrhage, heal ulcers, and arrest the progress of tuberculosis? How does she establish immunity against typhoid fever? Our partial solution of these secrets has unquestionably saved the lives of hundreds of thousands during the last two decades; and further discoveries will make possible prevention and cure of disease such as is "undreamed of in our philosophy." Chronic disease represents Nature's failure to effect cure. By knowing her methods and by forethought, we can prevent disease and by intelligent aid, cure it.

What is wrong with "drug therapy?" Chiefly its limitation, and its narrow scope. Under certain conditions, certain amounts of certain drugs will produce certain effects for certain lengths of time. The duration of the action is usually short and the element of time is therefore important. If sodium nitrite succeeds in lowering blood pressure for 1 or 2 hours, what innumerable doses are taken when the treatment is continued throughout a period of 10 or 15 years! Or take another example familiar to all of us. If sodium bicarbonate relieves the distress of chronic peptic ulcer, think of the amount of soda consumed in the course of 20 years! Ingenious physicians should be capable of devising a better regimen than this. But the surgeon replies, "Ah, ha! we do better than that; we do a gastro-enterostomy and thereby permit healing to take place." Yes, but what of hypertension? What does the surgeon do for it? Absolutely nothing. Having nothing to suggest, he calls this a "medical disease"; but his attitude is not justifiable. Eventually, surgery may be able to offer more than medicine does for hypertension. At least the surgeon should retain a working interest in this field.

Drugs are valuable, of course. Anæsthetics and antiseptics are indispensable, even to surgery; in fact, they have made modern surgery possible. Others are life-saving and health-giving: specific remedies, drugs that relieve distressing symptoms and tide the patient over a crisis until Nature has had her chance, drugs that supply specific deficiencies when Nature has failed to produce a sufficient amount of her own products. Medicinal treatment is most potent when it most closely simulates Nature. Recently this has meant the utilization of animal products as well as plant products. Even when we have secured the suitable products we still must learn Nature's secret of supplying them to the body. The discovery of insulin was the greatest triumph of modern medicine, but this valuable substance is administered through a hypodermic needle, a crude method compared with Nature's.

I have already acknowledged my growing respect for surgery, which in the face of great risks in certain conditions, undertakes to remove certain offending agents, substances, tissues, or organs, in the endeavor to effect a cure. The results, as a rule, are more quickly realized and are more lasting than those

[1] Read before the Clinical Congress of the American College of Surgeons, Detroit, Michigan, October 5, 1927.

derived from medical treatment. However, surgery also has its limitations. When structures are removed, the body is deprived of these parts and frequently certain processes are not re-established. Surgery is safe only in certain fields. Its greatest success depends on the removal of the seat of disease—an organ or a part of an organ, or on the re-adjustment of mechanical factors. As a rule, it is incapable of supplying the demand if underfunction exists, unless underfunction results from mechanical obstruction.

The surgeon having attained a certain degree of success may be tempted to overemphasize the value of his own work and sometimes to overlook material assistance which the physician or the laboratory can contribute. The viewpoint of the surgeon is mechanical, organic, and anatomical; that of the physician is functional, physiological, and chemical. Each viewpoint is important but not paramount. We are all equally guilty, all "worshippers of Baal": surgeons at the altar of surgical technique and physicians at the altar of clinical and laboratory examinations and drug therapy. There is need of better team work, of closer association in the treatment and investigation of disease. In the realm of surgical practice, closer co-operation must depend on the surgeon, since such co-operation can be developed only at the invitation of the surgeon. Otherwise, the physician lacks the opportunity, no matter how eager he may be to participate in the solution of problems involved in surgery.

According to the latest mortality statistics, the most frequent messenger of death is heart disease; consequently it is a complication which must be daily considered in surgery. From the standpoint of physician and surgeon alike, diagnosis in this field is fairly accurate. Our ideas concerning prognosis are not so well defined. But since the prognosis in cardiac disease is of vital importance in both the therapeutic effect and the risk of the operation, it merits consideration by every surgeon. Information is derived largely from three sources: the symptoms, the local and general signs, and the laboratory data. Experience from both the medical and surgical sides is obviously important.

Fig. 1. Extracorporeal loop.

CARDIAC DECOMPENSATION

CASE 1. The patient was an elderly woman with prolapse of the uterus which has existed since the birth of her seventh and last child 20 years previously. She had suffered from frequent colds, marked dyspnœa at times, and considerable œdema.

On examination the heart was found to be very large, measuring 17 centimeters in width. A diagnosis was made of chronic myocarditis and hypertension, and an electrocardiogram revealed the T-wave to be diphasic in leads I and II. Treatment consisting of rest; digitalis and theocin for the support of the heart and the control of the œdema; a turpine hydrate mixture for the cough; and sodium nitrite for the control of hypertension was prescribed.

Although the patient is now free from œdema, she still has dyspnœa which is quite marked, even when she is resting. The heart is still greatly enlarged, the systolic blood pressure is 220, and the diastolic 110, and surgical risk continues to be unfavorable. Inasmuch as her health does not permit her to be up and about, and since the prolapse takes care of itself while she is in the prone position, I concur in the opinion that surgical procedure is, for the present, unnecessary.

The second case[1] is one selected from the service of H. S. Plummer, who has contributed so largely to our knowledge of diseases of the thyroid and who is likewise a pioneer in the field of the medical management of surgical diseases.

[1] Inasmuch as the other cases presented in Detroit had no surgical bearing, they are not pertinent to the subject under discussion. Consequently I am presenting thumb-nail sketches of selected cases from the records of the Mayo Clinic.

TABLE I.—GRAVITY OF VARIOUS CARDIOVASCULAR DISEASES FROM THE MEDICAL POINT OF VIEW ACCORDING TO RISK

Clinical type	Gravity of outlook (grade)	Factors bearing on operability
Myocardial insufficiency; cardiac decompensation	4 to 3	Dyspnœa, œdema, cyanosis, or pain; response to therapy; age of patient, and myocardial damage.
Pericarditis with effusion especially if purulent		Degree of sepsis and effects of drainage.
Malignant hypertension		Life expectancy (averages about 2 years); retinal, cerebral cardiac and renal evidence (important).
Coronary sclerosis (*sine dolore*)		Degree of disability and myocardial damage as shown by electrocardiogram (10 to 40 per cent of such cases overlooked by physicians).
Coronary sclerosis with (angina pectoris)		Degree of disability; vascular and myocardial damage.
Syphilitic aortitis; aneurism		Prognosis grave and medical treatment unavailing.
Cerebral arteriosclerosis; cardiosclerosis; sclerosis of kidneys		Impairment of function and structural injury; age of patient (medicine offers little beyond rest).
Valvular disease; enlarged heart	3 to 2	Response to therapy and degree of functional and structural impairment. (Rest may restore function.)
Low blood pressure states; hypotension: systolic pressure 95 mm. or less		Subject to postoperative complication in older subjects.
Sclerotic disease of extremities without gangrene		Possibility of diabetes (no contra-indication unless arterial insufficiency exists).
Pericarditis: chronic adhesive; serofibrinou		Response to therapy; myocardial status (cacodylates of value in acute pericarditis).
Peripheral vascular disease: Raynaud's disease; Buerger's disease	2 to 1	Low blood pressure; risk usually moderate; pulmonary emboli not observed.
Valvular heart disease with normal heart		Age and myocardial status.
Benign hypertension		Age of patient; structural and functional impairment.

CASE 2. A married woman, 51 years of age, had suffered from exophthalmic goiter for 2 years or more. Her weight had dropped from 165 to 120 pounds. Auricular fibrillation had been present for 6 months. The basal metabolism was +62.

The patient was placed in the hospital and given iodine (Lugol's solution) 10 minims, 4 times a day. The first 5 days the afternoon pulse was 150 to 160; on the sixth day it was 98, and the basal metabolism was +39. The pulse rate during the second week was from 70 to 85. On the nineteenth day, thyroidectomy was performed. The fourth day after the operation, auricular fibrillation appeared and lasted for 24 hours.

With all due respect to the surgical procedure, the results in this case were due as much to the medical treatment as to the excellence of the operation. It is interesting to note that the patient's abnormalities all responded markedly to iodine, that digitalis was not employed, and that the patient stood the operation successfully despite the fibrillation which might have been considered as a serious contra-indication.

In connection with this paper, I have felt that it might prove helpful to bring together in a simple way certain medical conceptions concerning the gravity of the outlook in various cardiac diseases, together with the surgical risk as we see it from a medical point of view. I have also indicated in a general way the medical treatment. In Table I these diseases are grouped according to the gravity of the outlook from a medical viewpoint, while in Table II the various types of arrhythmia are considered.

The electrocardiograph is important in the consideration of surgical procedures because

TABLE II.—IMPORTANCE OF ARRHYTHMIA MEDICALLY AND SURGICALLY

Type of arrhythmia	Gravity of outlook		Treatment
	Medical	Surgical (grade)	
Extrasystoles	No added risk *per se*	1 to 0	Assurance, bromides, quinidine
Paroxysmal tachycardia	No added risk *per se*	1 to 0	Assurance, pressure on vagus, quinidine
Heart block: (Complete bundle branch)	65 per cent dead within 11 years	4 to 3	Restriction of activities, digitalis, care of special manifestations.
(Incomplete bundle branch)	Somewhat less	3 to 2	
Delayed A. V. conduction	Great if organic, less great if functional	4 2	Atropine determines its nature.
Complete heart block	Great	4	Thyroid extract, barium chloride, digitalis.
Auricular flutter	30 to 50 per cent dead within 5 years	3 to 2	Rest, digitalis, quinidine.
Auricular fibrillation	40 per cent dead within 15 months	3 to 2	Rest; digitalis except in the presence of hyperthyroidism.

it furnishes information of greatest prognostic significance. Striking statistical studies in this field have been carried on by Willius. T-wave negativity is of great significance prognostically and of still greater significance when aberrant ventricular complexes are superimposed. The importance of this is apparent from a study of Table III. Willius has found that 90 per cent of patients with T-wave negativity have coronary sclerosis or very large hearts (500 grams or more); excessive enlargement of the heart and coronary sclerosis both indicate a very bad prognosis.

Relative to general prognosis in cardiac disease, it is important to determine the incidence of cardiovascular disease from death following operation. I shall present an analysis of the cause of death following laparotomy in 198 cases, which was compiled by Robertson from the records of the Mayo Clinic for 1926. It will be seen that pulmonary embolism, hæmorrhage, and cardiac disease, taken as a group, account for about 20 per cent of the surgical fatalities in this series (Table IV).

I shall discuss a few of the more important factors causing postoperative death, particularly from the standpoint of the physician's interest and of the advantage of team work. Of necessity I must confine myself to work with which I am familiar and hence will discuss chiefly studies carried on in the wards and laboratories of my service.

PULMONARY EMBOLISM

In the Mayo Clinic, pulmonary embolism accounted for 9.6 per cent of the deaths after laparotomy in 1926, more than 6 per cent of the postoperative deaths during the last 10 years, and for more than 7 per cent of the total postoperative deaths during the history of the clinic. The following case is typical.

CASE 3. A woman, 58 years of age, from the West Indies, came to the Mayo Clinic, in August, 1927, because of a pelvic tumor. Menstruation had ceased 2 years before; since then there had been a constant yellowish discharge. Three months previously, severe menorrhagia appeared and lasted for 1 week. After that, slight bleeding had occurred when the patient walked. At physical examination the patient appeared normal and healthy. The cervix was small and a large, hard tumor was continuous with it. A diagnosis of uterine fibromyoma was made and on August 11, a subtotal abdominal hysterectomy, bilateral salpingectomy, and oophorectomy were performed for multiple fibromyomata of the uterus, bilateral cystic oophoritis, and salpingitis. The patient did well until the eleventh day. She was sitting in a chair when she suddenly became dyspnœic, and cyanotic and died within half an hour. Necropsy revealed pulmonary embolism, probably originating in the left iliac vein. There appeared to be no other cause of death.

TABLE III.—ELECTROCARDIOGRAM IN PROGNOSIS

T-wave negativity	Gravity of outlook		Treatment
	Medical	Surgical (grade)	
In leads I and II, I, II, III	60 per cent dead within 1 year	4 to 3	Rest and restriction
Leads II and III	30 per cent dead within 1 year	2	Care of myocardium
With additional aberrant Q.R.S.	86 per cent dead within 1 year	4	

TABLE IV.—IMMEDIATE CAUSES OF DEATH FOLLOWING LAPAROTOMY

	Cases	Per cent
Peritonitis	75	37.8
Bronchopneumonia	25	12.6
Pulmonary embolism	19	9.6
Other pulmonary complications	6	3
Hæmorrhage	12	6
Peritonitis with bronchopneumonia, etc.	15	7.5
Cardiac disease	9	4.5
Carcinomatosis	8	4
Hepatic disturbances	9	4.5
Urinary disturbances	4	2
Intestinal disease	7	3.5
Miscellaneous	9	4.5
Total	198	

As a result of the all too frequent occurrence of pulmonary embolism, a group of us have become interested in the disease with the hope of finding some method of preventing it or at least of lowering its incidence. A method has been devised for the study of vivithrombosis in an extracorporeal circulatory loop. Figure 1 shows a little apparatus which can be attached to the carotid artery and jugular vein of the rabbit so that the blood will circulate through it. The glass parts of the apparatus are connected peripherally by a collodion tube, which permits of dialysis. This tube is immersed in a solution of sodium chloride if desired, or in any solution of any drug or substance capable of permeating the blood stream by means of dialysis. This method affords an unusual degree of control of physical, physiological, pharmacological, and pathological factors and, by its use we hope to be able to throw additional light on the subjects of thrombosis, clotting of blood and, indirectly, perhaps of pulmonary embolism.

Whereas with this apparatus, coagulation occurs normally in from 4 to 6 minutes, it is delayed many hours by the addition of suitable doses of heparin which, according to Howell, its discoverer, is the normal anticoagulant present in all normal blood. When heparin is used, white thrombi are deposited on the surface in the course of 2 hours despite the fact that fibrin is not deposited and clotting has not occurred. It is possible, therefore, by the injection of heparin to control fibrin deposition and, when it is given in larger amounts and continuously, to prevent entirely the deposition of white thrombi. Johnson has been able to show functionally active platelets in mammalian blood. The fibrin web as well as the platelets are visible on the collodion membrane. This, of course, becomes the mesh-work of the clotting. In subnormal coagulation, such as occurs in jaundice, these strings of fibrin are scant or short and apparently ineffective. It is significant that in experimental obstructive jaundice, circulation through the apparatus may be maintained for hours and that practically the same conditions can be obtained by the intravenous administration of bile salts.

In a statistical study of records of cases of pulmonary embolism, Henderson brought to light the interesting facts (Table V) that the incidence of pulmonary embolism in the Mayo Clinic is approximately the same for operation in the upper and in the lower abdomen. Thus, embolism occurred in 75 cases following operations on the stomach, gall bladder, and bile ducts and in 86 cases following operations on the uterus and its appendages, the bladder, and the prostate.

But, according to the frequency of operations, a great difference does exist. Thus the incidence of pulmonary embolism in operations on the stomach and duodenum or on the gall bladder and biliary ducts is approximately 1 in 300 operations; in prostatectomy it is 1 in 200 cases; and in cystostomy, preliminary to operation for hypertrophy of the prostate, it is 1 in 60 cases. The source of the emboli is obviously important. Table VI shows that the femoral, pelvic, and prostatic veins are the chief contributors.

Changes occur in the blood subsequent to operation. Allen has made a careful study of

TABLE V.—PULMONARY EMBOLISM FOLLOWING INTRA-ABDOMINAL OPERATIONS

Operations on	Total number of operations, 1917–1926	Cases of embolism	Incidence of embolism, per cent
Gall bladder and ducts	11,689	37	0.31
Stomach	12,453	38	0.30
Uterus and appendages	11,961	51	0.42
Bladder:			
Cystostomy for hypertrophy of prostate	1,104	19	1.72
Prostatectomy	1,959	11	0.56
Operations other than simple cystostomy	922	5	0.54
Colon	2,389	20	0.83
Abdomen:			
Exploration		8	
Paracentesis	321	1	0.30
Appendix	12,356	5	0.04
Kidneys	3,635	5	0.10
Rectum	1,982	5	0.25
Spleen	317	4	1.26
Subdiaphragmatic abscess	29	1	3.40
Omentum (tumor)	2	1	50.00
Small bowel	991	3	0.30
Ventral hernia	1,235	4	0.30

the blood during the 10 days subsequent to operation. It appears that within a day or 2 after operation there is marked increase in the number of leucocytes and a decrease in the number of erythrocytes and that from the third day on there is a decrease in the total fats of the blood and practically a 100 per cent increase in the fibrin of the blood, associated with slight decrease in the coagulation time which is most striking about the sixth day.

Snell has studied the relationship of obesity to fatal postoperative pulmonary embolism and has concluded that there is a group of patients, more than 50 years of age, obese, and with normal or subnormal blood pressure, who are particularly susceptible to pulmonary embolism as a postoperative complication. Brown, in studying a group of 150 cases of postoperative phlebitis, found that although pulmonary infarction was relatively common

TABLE VI.—SOURCE OF EMBOLI

	Cases
Iliac vein	64
Femoral vein	55
Pelvic veins	43
Prostatic plexus	18
Vena cava	13
Right auricle	10
Renal vein	7
Axillary vein	3
Right ventricle	3
Ovarian veins	3
Hæmorrhoidal veins	1
Deep epigastric vein	1
Jugular vein	1
Vaginal plexus	1
Cervical plexus	1
Subclavian vein	1
Innominate vein	1
Azygos vein	1

in phlebitis, fatal pulmonary embolism was extremely rare. An organism capable of inducing intravascular clotting in animals has been isolated from pulmonary emboli in several instances by Rosenow.

Walters and Coffey have attempted to decrease the incidence of pulmonary embolism by a regimen involving systematic moving of the extremities. Walters has stressed the importance of the vigor of blood flow and has attempted to strengthen the circulation by the administration of desiccated thyroid prior to operation. In his series of more than 3,000 cases there was not a single instance of pulmonary embolism in patients under 70 years of age. Coffey has noted the importance of exercising the legs and breathing deeply.

Sufficient time has not elapsed to allow definite conclusions to be drawn concerning the efficacy of these measures; however, the question of pulmonary embolism is one that demands the thoughtful consideration of every surgeon. Pulmonary embolism is always a tragedy, is always untimely and harrowing to the doctor and to the patient's family. It always appears to be an unnecessary cause of death and is a challenge to our combined forces.

HYPERTENSION

Essential hypertension affects surgical risk although, in the more benign forms, it adds little or nothing to the risk, in fact, at times it may even afford a slight factor of safety because it insures a vigorous circulation.

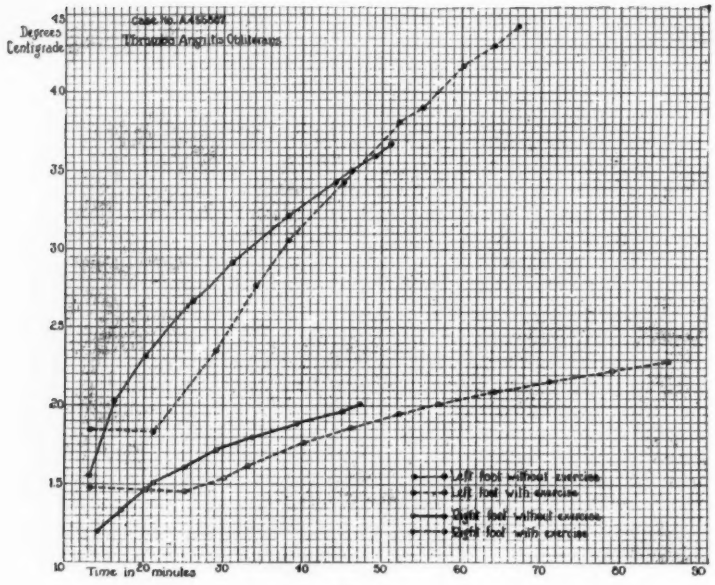

Fig. 2.

Malignant hypertension, on the other hand, is usually fatal within 2 years, and consequently entails an extremely grave outlook with or without surgical measures. Minor processes, such as removal of teeth and infected tonsils, are hazardous and major operations are unjustifiable except under unusual conditions or when they are undertaken for the relief or cure of the disease itself.

CASE 4. A man, aged 34, came to the Mayo Clinic chiefly because of headaches and hypertension which had been present for 2 years, and painless hæmaturia for 2 weeks. A diagnosis of malignant hypertension was made. The blood pressure and fundi were typical of malignant hypertension. The electrocardiogram confirmed the clinical diagnosis of severe myocardial disease, the T-wave being inverted in leads I and II. There was no anæmia, and the renal function was adequate. Roentgenograms of the kidneys, ureters, and bladder were negative. Cystoscopic and pyelographic examinations were negative. The hæmaturia was apparently of the so-called essential type, probably related to the hypertension.

Because of the presence of septic tonsils with fluid pus and in view of the fact that the renal status was still good, a tonsillectomy was performed. The operation was followed by profuse tonsillar bleeding with the formation of a large hæmatoma in one tonsillar fossa. The patient was extremely ill for more than a week; fever was as high as 102 degrees F. on the fifth day after operation. Recovery appeared doubtful. Following tonsillectomy, the hæmoglobin dropped to 45 per cent (Dare) and erythrocytes to 3,230,000. Recovery was gradual. The patient was dismissed about 2 weeks after the operation. He died at home 13 months later from apoplexy.

In the diagnosis of hypertension and vascular disease, information of great value can be derived from the study of the eye grounds and the capillaries. The fundus is diagnostically the polished surface that takes the finger prints of disease and prognostically is Belshazzar's wall whereon the fate of the patient is frequently written. No other structure of the body of like size affords so much pathognomonic evidence. The convenient electric ophthalmoscope removes the last excuse that any physician or surgeon might have for neglecting the fundus examination in cases of vascular disease.

Because of Lombard's investigations the capillaries of the nail fold can now be readily studied. They afford valuable information at times concerning the existence of changes in the capillaries of the body as a whole.

Hæmorrhage from the capillaries, a familiar observation in the fundus of the eye in nephritis, can often be seen in the nail folds. These capillaries have been studied for several years by Brown and Sheard and may now be photographed.

What is the cause of death in hypertension? Table VII shows the outcome in a series of cases studied by the late Theodore Janeway, who was, in his time, perhaps, the outstanding student of this subject in America. According to him, the most frequent causes of death were cardiac insufficiency, uræmia, cerebral apoplexy, and angina pectoris. Keith, Wagener, and Kernohan found that in malignant hypertension, cerebral accident was responsible for death in about a third of the cases and that general cardiorenal failure with œdema of the lungs constituted the most frequent terminal picture.

TABLE VII.

Causes of death	Male	Per cent	Female	Per cent	Total
Gradual cardiac insufficiency	48	35.0	12	25.5	60
Uremic convulsions, coma, or gradual uræmia	31	22.6	15	31.9	46
Cerebral apoplexy or its results	20	14.6	9	19.1	29
Angina pectoris	10	7.3	.....	.....	10
Œdema of lungs	6	4.4	1	2.1	7
Progressive anæmia	1	0.7	2	4.3	3
Pericarditis	1	0.7	.....	.....	.....
Complicating acute infectious disease	9	6.6	4	8.5	13
Other accidental causes	7	5.1	2	4.3	9
Unknown	25	.....	3	.....	.....
Sudden	4	2.9	2	4.3	6
Total	162		50		212

I am of the opinion, although I have little proof, that hypertension in the early stages might be better treated surgically than along the medical lines now employed. A recent case of intermittent paroxysmal hypertension reported by C. H. Mayo is fertile in suggestions. This hypertension, malignant in character, was caused by a peculiar tumor in the region of the left suprarenal gland. The removal of a growth, probably of the splanchnic sympathetic nerve, brought about immediate and, to date, permanent cure. In another case of malignant hypertension, the greatest symptomatic relief that I have ever witnessed was the result of lumbar sympathetic ganglionectomy performed by Adson. The patient, a chronic invalid, was restored to almost complete health and returned to full-time work at his previous occupation for a period of 15 months. I have been unable to learn the exact cause of death. The idea I wish to convey is that the surgeon should not look on hypertension as a medical disease, but should make certain that he is not overlooking an unusual opportunity for the control of one of the most common and serious diseases.

PERIPHERAL VASCULAR DISEASE

Peripheral vascular disease constitutes another field which co-operative studies illuminate. Brown and Adson are clarifying our conceptions of the cause and nature of pain in the peripheral vascular diseases and incidentally are attempting to save extremities which would heretofore have been sacrificed by amputation. Brown has measured by the foot calorimeter the heat transferred from the extremity and has also studied the surface temperature of the extremity before and after surgical procedures—sympathetic neurectomy and ganglionectomy—carried out by Adson. He has shown in many instances, a marked increase in the elimination of heat from the extremity after operation sometimes amounting to 200 or 300 per cent, invariably accompanied by an increase in local temperature. Pain has been satisfactorily controlled in many instances. Raynaud's disease of the foot has been practically cured in several instances and excellent results have been obtained in 7 of the 9 cases of Buerger's disease in which lumbar sympathetic neurectomy was performed which shows the typical change in the elimination of heat before and after operation in suitable cases (Fig. 2). In Case 5, amputation seemed unavoidable, but complete healing followed sympathetic neurectomy and satisfactory conditions obtained at least for a year. Healing may be accelerated by the use of vaccines. In our experience the greatest relief from this type of pain has followed the intravenous use of vaccines or radium salts.

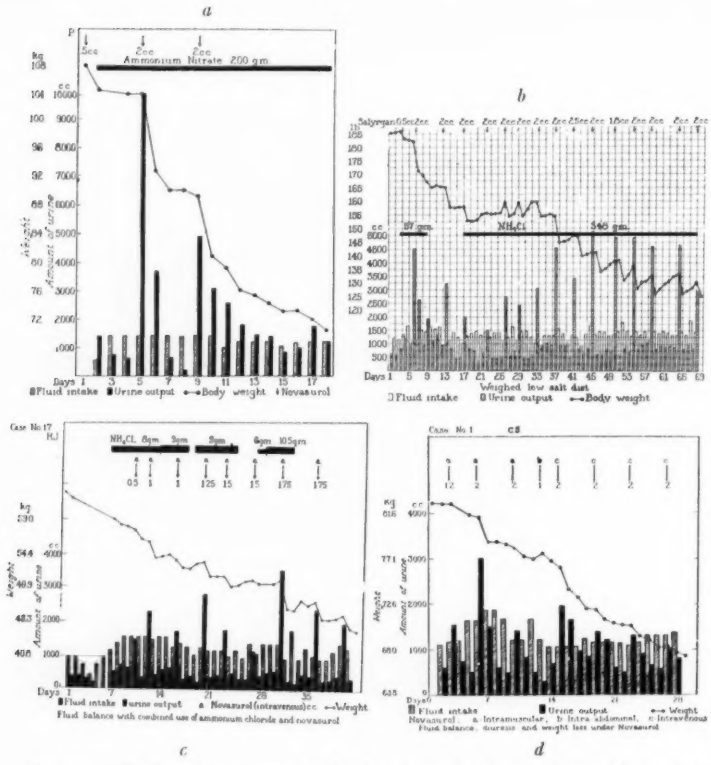

Fig. 3. a, Cardiac decompensation; b, chronic nephrosis; c, polyserositis; and d, portal cirrhosis.

Brown has established a new criterion for operability in such cases, based on the amount of increase in local temperature of the foot following the induction of fever by vaccines. In unsuitable cases there is no increase in peripheral temperature. This promises to be a practical clinical test of decided surgical value.

CASE 5. This is a case of thrombo-angiitis obliterans involving both lower extremities. An Austrian Jew, aged 54 years, a travelling salesman, came to the Mayo Clinic complaining of pain in both feet, palmar arches, and great toes. The pain could be entirely relieved by rest but would return after the patient walked 2 blocks. Examination of the extremities showed, in both legs, intermittent or questionable pulsations in the posterior tibial and dorsalis pedis arteries. Both popliteal vessels showed pulsations, and all pulsations were present in the vessels of the wrists. With elevation, there was a slow return of color after the intense rubor occasioned by leaving both feet in the dependent position for 3 minutes. Early trophic changes were present in the right great toe. No calcification was evident in the vessels of the legs on roentgenographic examination.

A diagnosis of thrombo-angiitis obliterans (Buerger's disease) was made. Bilateral lumbar sympathetic ganglionectomy was carried out. Following the operation the palpable temperature in the feet increased. In the right great toe, with the thermocouple method, an increase from 24 to 29.4 degrees C. was found. The temperature of the dorsum of the foot increased from 29.1 to 30.8 degrees C. The rate at which heat was lost was determined by the foot calorimeter: before operation the right foot eliminated 0.41 calories for each square inch of surface area and after operation 0.69 calories, an increase of 70 per cent. The pain in the feet disappeared and recovery was uneventful.

When the patient returned a year later, the disease had apparently progressed no further. The feet looked quite healthy. The only symptom was a sensation of fatigue across the base of the toes after walking 4 or 5 blocks.

RENAL INSUFFICIENCY AND SURGICAL RISK

Renal insufficiency is not included in the scope of this paper except insofar as it is the result of renal arteriosclerosis. Functional tests have developed to such a high degree of accuracy that it is now possible in either medical or surgical lesions of the kidney to determine the function of the kidney adequately, and this determination may constitute the basis for surgical judgment. It should be remembered that the content of urea in the blood may be controlled at times by diet but the fixed nature of the blood creatinine constitutes, to my mind, at least, the best prognostic indication relative to renal insufficiency. The phenolsulphonephthalein test, on the other hand, is probably the most practical and reliable for general use.

SHOCK AND GUM ACACIA

Hypotension rarely causes great concern prior to operation but is frequently important subsequent to operation, especially in shock. During the World War, shock was studied intensively. Among other things, the value of gum acacia in treatment was established by Bayliss. Keith, who worked on shock in the British medical service during the War, has continued his interest in this problem; as a result gum acacia is being used at the Mayo Clinic in postoperative shock. The work has been carried on by Huffman, who states: "In 50 cases of severe postoperative shock, marked improvement followed the intravenous use of gum acacia saline solutions. In a number of instances, blood transfusion was also used both before and after the acacia. The improvement in pulse and blood pressure seemed no greater, if as great, when compared to the acacia infusion. In shock accompanying hæmorrhage the use of the acacia solution will remedy the immediate conditions and permit the replacement of the hæmoglobin in a more leisurely fashion or even make transfusion unnecessary." A typical case report follows.

CASE 6. A woman, aged 47, came to the clinic because of a large tumor in the lower part of the abdomen, which had been present for 3 months and was rapidly increasing in size. There had been a loss of weight of about 20 pounds. Hæmoglobin was 50 per cent. It was believed that the tumor was malignant. At operation, a large diffuse fibrosarcoma was found arising from the posterior surface of the uterus. It was widely adherent so that much trauma and considerable loss of blood from oozing surfaces occurred. A profound state of shock supervened, evidenced by rapid, feeble pulse, cyanosis, rapid respiration, and a blood pressure too low to determine with certainty. At this time, administration of 6 per cent gum acacia in a solution of sodium chloride was started intravenously. Before 300 cubic centimeters had been given the blood pressure had increased to 80 systolic and 60 diastolic and by the time the injection of 750 cubic centimeters was completed, the systolic blood pressure was 120 and the diastolic 70; the pulse was slower and full and the yawning practically gone. The improvement was subsequently maintained and the patient made a splendid recovery from the operation.

THE OXYGEN TENT IN THE TREATMENT OF PNEUMONIA

As already indicated, bronchopneumonia and other pulmonary complications account for approximately 15 per cent of the postoperative mortality at the Mayo Clinic. Oxygen treatment has been accorded a trial in pneumonia during the last 2 or 3 years. The work of Barach, Binger and Stadie, and Boothby and his colleagues with the oxygen chamber has shown that in the course of a year a number of lives can apparently be saved by oxygen treatment. Binger and Wilder of the medical staff of the Mayo Clinic have been collaborating with Judd and other members of the surgical staff in utilizing the oxygen tent in all postoperative cases in which there is cyanosis, bronchopneumonia, or capillary bronchitis, and in a small proportion of the cases in which the postoperative course is febrile. The disappearance of cyanosis under medical treatment is striking. The almost immediate decrease in temperature which occurs in practically all cases is marked, and, so far, unexplained. Our data thus far do not permit of a definite statement; however, the surgeons have encouraged further development of this work, the provision of several machines, and a specially trained personnel.

CASE 7. A man, aged 28, came to the Mayo Clinic early in January, 1927, giving a history typical of peptic ulcer that had existed for 2 years. Because of frequent hæmorrhage, operation was advised and

a posterior gastro-enterostomy and appendectomy were performed, on January 11. On the same day the temperature rose to 102.5 degrees and the pulse to 120. January 12, bilateral postoperative pneumonia was present with dullness on percussion, râles at both bases, and bronchial breathing. The roentgen-ray examination showed infiltration of both lower lobes. Blood culture was negative. The sputum contained streptococcus hæmolyticus but not pneumococcus. The prognosis was grave. The oxygen tent was employed and within 6 hours the temperature, cyanosis, and pulse responded but the oxygen was continued for 10 hours longer. There was a mild recurrence 8 days later and oxygen was administered for 6 hours on each of 2 days. The patient recovered completely and was dismissed January 24.

THE CONTROL OF ŒDEMA

Generalized œdema is almost invariably of serious import. Recently our ability to cope with this complication has been considerably enhanced. Merbaphen (novasurol, salyrgen) has been used in Europe for several years in the treatment of cardiac œdema. Recently we have been utilizing merbaphen in almost all forms of œdema. Keith and I found that it was almost as specific in ascites secondary to portal cirrhosis and Banti's disease. Keith and his associates have still further increased its value by administering ammonium chloride or ammonium nitrate orally at the same time. Figure 3 shows the effects of merbaphen and of these combined diuretics in 4 types of œdema associated with cardiac disease, nephritis, portal cirrhosis, and polyserositis. These results are not only of value because of the therapeutic triumph involved, but because they throw some light on the mechanism of the production and on the nature of œdema. Irrespective of the organ primarily responsible for the œdema, physicochemical changes effected by means of merbaphen have resulted in its disappearance. The use of the combined diuretics has yielded the most satisfactory results that I have ever encountered in the management of œdema. It removes the necessity for paracentesis in many instances and also for omentopexy. It constitutes at times a "medical tapping."

PREVENTION OF CARDIOVASCULAR DISEASES BY SURGICAL MEANS

In the general discussion of the cardiovascular complications, it is but fair to add that surgery in itself is valuable in the prevention of the development of cardiovascular disease. The early removal of infected tonsils has probably saved hundreds of thousands of hearts from the ravages of rheumatism or other forms of infection. The proper care and, when necessary, the removal of infected teeth have probably been a great safeguard against subacute bacterial endocarditis. The removal of a hyperfunctioning adenomatous thyroid gland protects the heart against the effects of hyperthyroidism.

The best surgery may profit from contact with good medicine. As a matter of fact, under ideal conditions, the pre-operative and postoperative care of the patient may be handled best by the intelligent co-operation of medicine and surgery. So strongly are we convinced of this that several combined medical and surgical services have been established in our hospitals. For success the spirit must be right. It demands mutual understanding, mutual sympathy, and mutual confidence. Team work is essential to optimal results in surgery. As this can come only on the invitation of the surgeon, the future of this movement rests largely in his hands.

JUVENILE EXOPHTHALMIC GOITER[1]

By ARTHUR B. McGRAW, M.D., Detroit, Michigan
From the General Surgical Division of the Henry Ford Hospital

DURING the past year, we have had the good fortune to encounter two typical cases of juvenile exophthalmic goiter, and in view of the recent reports of Dinsmore and Helmholz, we have been led to place these cases on record, and review as much of the literature pertaining to juvenile exophthalmic goiter as has been accessible to us.

Arbitrarily assuming that the term "juvenile," includes all patients under 15 years of age, we have found, in addition to Dinsmore's and Helmholz's independent series of 46 and 30 cases, respectively, reports from various countries during the past 75 years of 48 cases. Thirty-nine of these case reports have been seen in the original. The remainder are quoted from Steiner, who collected and published 31 cases in 1897, and whose article is the most comprehensive and searching review of the early literature on this subject that we have encountered.

The two new cases we have to report are as follows:

Case 1. Evelyn D., an only child, 6 years of age, was first seen on December 2, 1926, in the outpatient pediatric division of the Henry Ford Hospital. Both parents were living and well. The child's paternal grandfather was the only member of the immediate family who had had goiter. The child had been a full term, 9½ pound baby, born spontaneously, after a 4-hour labor, without any observed birth injuries or prenatal abnormalities. There were no immediate postnatal troubles. She was nursed at breast for only a half month because of the lack of mother's milk. She was then fed cow's milk and water until she was 9 months old. No digestive disturbances occurred and she was never finicky about her food. She was physically normal; mentally slightly precocious. As a baby she had always been nervous, and her parents thought she was going to have St. Vitus' dance when she was 3 years old as she was very active by day and restless at night. The child developed a light case of pertussis at 3 years of age. She was vaccinated before she came to the hospital.

In the early months of 1926, her parents noticed the presence of tachycardia and a tendency to perspire easily. The patient came down with a severe case of measles about May 1, 1926. Following the measles, a severe cough and occasional vomiting developed, and she was taken to the Children's Hospital, Detroit, Michigan, for about a month. Restlessness, nervousness, and irritability were noted. As she had always been subject to colds and tonsillitis, a tonsillectomy and adenoidectomy were performed in a doctor's office, under ether anæsthesia during June, 1926. She then lost weight in spite of a ravenous appetite. Nervousness, restlessness, and tachycardia were aggravated and emotional irritability was noted. She was kept at the Children's Hospital for 8 weeks, beginning in July, 1926. Exophthalmos was first noticed during this period, and she suffered from otitis media. Beginning in July, she was given 2 drops of tincture of iodine in water each day, more or less regularly, for 5 months. On this therapy she gained a few pounds in weight but otherwise did not improve. During the 2 weeks immediately preceding admission to the clinic, all symptoms, especially the exophthalmos, had increased.

Physical examination. On admission to the clinic, the child weighed 48½ pounds; she was 48¾ inches tall; her temperature was 99.8 degrees F.; pulse, 125; respiration, 24. She appeared to be a reasonably well nourished and developed, decidedly hyperactive child. The hyperactivity was characterized by the "purposeful but useless" movements which Plummer emphasizes in contradistinction to the purposeless character of choreiform twitchings. Posture was normal. There was a coarse, rapid tremor of hands and arms; slight, non-tender swelling of the synovia of the left ankle, but no redness. The skin, especially of the hands, was moist. Surface temperature was elevated. Moderate generalized muscular weakness and accelerated fatigability were noted. The knee jerks were hyperactive, but the superior abdominal and pupillary reflexes were relatively normal. There was moderate enlargement of the tonsillar nodes. Exophthalmos was present in moderate degree. The von Graefe, Stellwag, and Moebius signs were positive. There was no nystagmus. The examination of the ears was negative. The teeth were normal in number and in good condition. The tonsils and adenoids had been removed; the mucosa was relatively normal. The nose had no obvious obstruction. A rather firm, diffuse enlargement of both lobes and isthmus of the thyroid was noted. No tracheal deviation or evidence of tracheal or œsophageal pressure was found. There was no disturbance of phonation. There was a slight bruit, but no thrill. Examination of the thorax showed equal expansion. No upper mediastinal increased dullness was detected. The lungs were negative to percussion and auscultation. The heart was slightly enlarged to the left. There were no mur-

[1]Submitted for publication, January 20, 1928.

murs or thrills. The sounds were of good quality and regular, but rapid. Pulsation of the carotids was noted. The examination of the abdomen was negative. The genitalia were normal. Diagnosis: exophthalmic goiter.

The child was admitted to the hospital December 2, 1926, for further study, treatment, and probable surgical therapy, with general orders for continuous rest in bed, high caloric diet, forced fluids, and strict limitation of visitors. The parents were permitted to visit the child for only 2 hours a day. Lugol's solution 5 minims, was given daily for 6 days; luminal, ¾ grain each day, later increased to 1½ grains, in divided doses, was also given.

Laboratory findings. Urinalysis showed a specific gravity of 1.006; reaction, acid; albumin, none; sugar, none (Benedict). Microscopic examination was negative. A blood count showed 4,200,000 red blood cells; hæmoglobin, 80 per cent; leucocytes, 7,500; polymorphonuclears, 24 per cent; basophiles, 2 per cent; small mononuclears, 72 per cent; large mononuclears, 2 per cent. The blood was classed as being in Group IV. Blood Wassermann reaction was negative. Further analysis showed blood sugar, 71 milligrams per 100 cubic centimeters; non-protein nitrogen, 25.2 milligrams per 100 cubic centimeters. The basal metabolic rate of December 3, 1926, was plus 84 per cent. An electrocardiogram showed sinus tachycardia, a moderate left ventricular preponderance, and moderate overactivity without definite evidence of damage to the myocardium. A roentgenogram of the thorax showed a slight cardiac enlargement. No enlarged thymus shadow was seen.

In the pre-operative period, the pulse rate averaged 130, occasionally reaching 150, or dropping to 110. The temperature ranged from normal to 100.5 degrees F. Respiration was normal. There was practically no improvement in the nervous manifestations. The child slept poorly. A basal metabolism test on December 11 gave a result of plus 65 per cent. At the end of 2 weeks the patient's general condition was slightly improved but not enough to warrant a subtotal thyroidectomy, so a ligation of the superior thyroid arteries was decided upon. The possible adverse effect of a thyroidectomy upon the child's growth was also considered and discussed at this time.

The first operation, December 16, 1926, was performed under ethylene oxygen anæsthesia. The skin was prepared with mercurochrome (Scott's solution) and a low collar incision was made. Each superior thyroid artery was ligated. The operation was completed in 25 minutes with a small loss of blood. The pulse was regular, of good quality, and at a rate of 120 to 140 per minute. The postoperative reaction was good except for slight acidosis which was controlled by glucose saline hypodermoclysis.

Following ligation, the pulse continued to average 130 beats per minute for 6 days and on the eighth dropped to an average of 120. The postoperative temperature was 99.5 to 102 degrees. The wound healed by primary union. There was very little clinical improvement. The patient was discharged for over Christmas day to try the effect of rest at home, the parents being carefully instructed as to diet and general care. However, within 3 days, diarrhœa appeared and the patient was brought back to the hospital. Diarrhœa was controlled within 24 hours. The pulse and temperature records were practically similar to those made when the child was first admitted, but after 7 days in the hospital a slight but definite decrease in pulse rate commenced. Nervous symptoms were on the increase, however, and a thyroidectomy was decided upon.

The second operation, January 8, 1927, comprised a subtotal thyroidectomy with removal of the isthmus under ethylene oxygen anæsthesia. The skin was prepared with mercurochrome, and the previous incision was re-opened. The operation required 45 minutes. Each lobe was found to be uniformly enlarged to what was estimated as about four times the normal size of the gland. By far the larger part of each lobe was removed, but the resection was not quite as radical as we ordinarily carry out on adults. The pulse was 120 to 130 during the operation and of good quality. Relatively little blood was lost. The postoperative course was better than after the first operation. There was no evidence of acidosis. The patient was at once able to retain fluids by mouth. For 6 days there was no change in the pulse but the restlessness, insomnia, and eye signs were much improved. Between the seventh and the fifteenth day, when the patient was discharged, the pulse rate gradually dropped to a level of 100 to 110. From January 14 to 20 she had quite a severe head cold with some involvement of the maxillary sinuses, but not of the ears. On January 18, deep roentgen-ray treatment was given over the thymic area (10 by 10 centimeters) at a focal skin distance of 12 inches, for 4½ minutes, through 3 millimeters of aluminum filter, with a current of 70 kilovolts, 5 milliamperes.

Since her discharge from the hospital the patient has gradually but steadily improved. Five weeks after the operation she weighed 55 pounds, pulse was 108; the basal metabolism rate was plus 6 per cent (kilogram basis), plus 16 per cent (surface area basis). There was only very slight tremor and exophthalmos and a marked improvement in restlessness and nervousness. After 3 months her weight was 54 pounds; pulse, 74; blood pressure, 95–70; basal metabolism rate, plus 1 per cent (surface area basis), minus 5 per cent (kilogram basis). There was no tremor or eye signs. Restlessness and nervousness had disappeared. Her appetite was good, and she slept well. After 11 months the pulse was 88; blood pressure was 100–60; basal metabolism rate, minus 2 per cent (surface area basis) and minus 7 per cent (kilogram basis). The little girl is at present, January, 1928, under ideal conditions in the outdoor department of a Detroit public school. She is under the supervision of a nurse, is fed two

of her three meals by a dietitian, and drinks 1½ quarts of milk daily. On cloudy days she is given graded exposure to the ultraviolet lamp. There is just a suggestion of exophthalmos, and a slight lag in the lid movements. There is no tremor. The child is still slightly restless but sleeps and eats well and is slowly gaining in weight. We hope to have her report for observation regularly at 3 month intervals. One year after operation, her basal metabolic rate is minus 5 per cent, her general health is good, and she appears quite normal as regards thyroid function.

CASE 2. Dorothy S., 7 years of age, was born in West Virginia of Polish parents. On August 12, 1927, she was brought to the pediatric department of the Henry Ford Hospital, because of cough, fever, and loss of weight, for 10 months. Her father and mother were living and well; likewise two sisters aged 13 and 4 years, and a brother aged 10 years. No goiter or tuberculosis was known in the immediate family. The child was born March 8, 1919. Delivery was spontaneous at 9 months, after one-half hour of labor. Postnatal cyanosis lasted for half an hour. The child weighed 7½ pounds at birth. At 1 year of age the child was able to walk, talk, and control the bladder and bowels. She fed herself at 2 years of age. Her school record had been satisfactory. Dentition was normal as to time and number of teeth erupted, but there had been numerous caries of both the first and second teeth. The child had otitis media between the ages of 4 and 5 years but not, however, since a tonsillectomy at 5½ years of age. At 6 years, she had German measles and at 6½ years, non-suppurative cervical adenitis. The child's diet and general habits were those of the average poor and rather ignorant family.

About 10 months before admission to the hospital, the child had a short attack of low fever and malaise. Since then there had been a progressive loss of weight. In past 3 months she had lost 8 pounds. She had a dry cough, was weak, became tired easily, and had headaches and some abdominal pain. She vomited only if given medicine. There was no diarrhœa. The eyes had gradually become prominent. She showed an increasing nervousness and a tendency to cry. The mother had noticed the thyroid enlargement, but was uncertain as to its duration. An X-ray picture 1 month before was said to have shown the presence of tuberculosis.

Physical examination. Patient was a pale, undernourished, wretched looking child with the facies of exophthalmic goiter. She was hyperkinetic, apprehensive, and cried easily. Her palms were moist, but the skin elsewhere was rather hot and moderately dehydrated. The muscles of the extremities were poorly developed. There were no bony deformities. A fine tremor was noted in the fingers. No choreiform movements were present. The spinal contour was normal. The reflexes were present and slightly hyperactive. Examination of the eyes showed a first degree exophthalmos; lid lag; and weak convergence. The maxillaries were cloudy and there was a mucopurulent discharge and marked irritation and crusting in both nostrils. The examination of the ears was negative. There were numerous dental caries with diffuse enlargement. No thrill or bruit was present. Both sides were about equal in size. The superficial and deep cervical gland showed first degree enlargement. The axillary and inguinal glands were palpable but not enlarged. The heart was not enlarged. The sounds were thudding and there was a short, non-transmitted apical systolic murmur. Blood pressure was 110–50. Examination of the abdomen revealed slight gaseous distention of the colon.

Laboratory findings. The patient's blood Wassermann was 1 plus (Kahn) and 111,000 (Kolmer). The mother's blood Wassermann was negative; the father's was not available.

The patient's blood count showed: hæmoglobin, 60 per cent; red blood cells, 3,900,000; leucocytes, 9,850; polymorphonuclears, 72 per cent. The urinalysis showed: a trace of albumin; a normal Benedict; some mucus; and many leucocytes and epithelial cells. The tuberculin test was positive in 16 hours (20 milligrams old tuberculin). The basal metabolic tests were as follows: on August 13, plus 23 per cent on the square meter basis and plus 40 per cent on the kilogram basis; on August 18, plus 16 per cent on the square meter basis and plus 28 per cent on the kilogram basis; on August 30, plus-minus 0 on the square meter basis and plus 10 per cent on the kilogram basis. X-ray pictures of the lungs showed enlarged tracheal and bronchial lymph nodes and slight peribronchial thickening, but no evidence of pulmonary tuberculosis.

Treatment. The child was placed on a régime consisting of continuous rest in bed; restriction of visitors; high caloric diet; forced fluids; Lugol's solution, 10 minims twice a day by mouth; and luminal, ¼ grain three times a day after meals. The nasal condition was treated externally with 5 per cent ammoniated mercury ointment, and internally by double suction and a 20 per cent argyrol spray. The patient was kept in the hospital for 17 days. Her rectal temperature varied from normal to 100 degrees F. It was more consistently normal during the last 4 or 5 days in the hospital. Her pulse ranged from 105 to 135 during the first 10 days, and from 90 to 110 during the remainder of her stay. Her general appearance, appetite, nervousness, and the local nasal condition all improved markedly. There was no change in her eyes or in the thyroid gland. A subtotal thyroidectomy was strongly advised but the mother refused to permit the operation, and insisted upon taking the child home to West Virginia. We have been unable to trace her since.

HISTORICAL

The majority of the 50 cases found in addition to those reported by Dinsmore and Helmholz are isolated examples of juvenile exoph-

TABLE I.—AGE OF ONSET OF SYMPTOMS IN SIXTY-FOUR CASES

	Cases	Per cent
Less than 1 year	3	4.5
1 to 5 years	14	22.0
6 to 10 years	25	39.0
11 to 15 years	22	34.5
Total	64	

TABLE II.—AGE OF FIRST OBSERVATION OF PATIENT IN SIXTY-FOUR CASES

	Cases	Per cent
Less than 1 year	1	1.1
1 to 5 years	8	12.5
6 to 10	20	31.0
11 to 15 years	35	55.0

thalmic goiter. The first recorded case we found was that of Henoch, reported in 1851. Other single cases were reported by Präel in 1857, Labarraque in 1860, Hawkes in 1861, Rosenberg in 1865, Demme in 1866, Bouchut in 1867, Gagnon in 1871, and Schwenkendick in 1873. In 1874, Jacobi reported 3 cases, and a fourth case in 1878. Meanwhile single cases had been reported by Chvostek, Dusch, and Gagnon in 1875, and by Sutton and Pepper in 1877. Baginsky and Holm each reported a case in 1879; Crohn reported a case in 1883, Baldwin reported 3 cases in 1884, 1887, and 1893; Lewin and Mueller each reported a case in 1888; Ehrlich, 1 case in 1889; Foerster, 1 case in 1890, and Demme and Kraus each reported a case in 1891. Steiner observed a case in 1892 and 2 cases in 1895; Kronthal, 1 in 1893, Hock, 1 case in 1895; Lewis, 5 cases in 1906, 1909, 1911, and 1912; Sawyer, 1 case in 1916; Buford, 1 case in 1922; and Heiman, 3 cases in 1923. In 1922, Klein mentioned 184 cases of juvenile exophthalmic goiter in a total series of 3477 cases of Graves' disease, but his article lacks a bibliography and he sometimes fails to state whose cases compose his series.

In comparison with the immense literature concerning adult exophthalmic goiter reported during the same period of 75 years, the total group of 157 cases discussed in whole or in part in this article, while fairly large in itself, does not seem to warrant any other conclusion than that true Graves' or Basedow's disease is of a distinctly rare occurrence prior to the establishment of puberty.

AGE OF ONSET

Accurate data as to the age of onset of symptoms are available in all of Helmholz's 30 cases, in 33 of our composite series of 50 cases, and in a single case reported by Ochsner. The various ages are grouped and shown in Table I.

It has been interesting and surprising to us to note that the onset of symptoms in the highest percentage of cases, including our own, fell between the ages of 6 and 10 years, i.e., from 1 to 4 years before the average age for the onset of puberty in children of northern latitudes.

Data are likewise available as to the age at which 64 of the cases were first observed and are shown in Table II. It will be seen that the highest percentage shifts over to the period between 11 and 15 years. There were 3 cases with sudden onset of acute symptoms and 2 cases in which symptoms in some degree had existed for 6 years before medical advice was sought. The average length of time elapsing between the onset and the first observation was a little over 1½ years.

ETIOLOGICAL FACTORS[1]

Various etiological factors were almost invariably advanced, discussed, and speculated upon at length in the reports of the nineteenth century, but not one of the authors of articles published since 1900, with the exception of Heiman, has ventured to describe any definite etiology. In 62 per cent of the whole series some possible predisposing or etiological factor has been mentioned; familial goiter in 29 per cent of the cases; a recent attack of acute tonsillitis in 13 per cent; of measles in 13 per cent; of pertussis in 9.5 per cent; of scarlet fever in 6.5 per cent; of rheumatic fever, pneumonia, diphtheria and "malaria" each in 3 per cent; of the recent onset of puberty in 3 per cent; of recent trauma or emotional strain each in 3 per cent; and remote trauma in 3 per cent.

[1]In the following paragraphs, statistics will be based on data from a composite series of 51 cases including the 31 assembled by Steiner, 5 by Lewis, 3 each by Baldwin and Heiman, our own 2, and single cases reported by Buford, Hock, Kraus, Pepper, Sawyer, Variot, and Zueber.

CONSTITUTION

Some mention is made of the general type or physical condition of 70 per cent of the children, but many of the terms used are too vague to be of much service. A report of good was made in 26 per cent of the cases; undernourished in 23 per cent; anæmic in 20 per cent; nervous habitus in 8.5 per cent; rapid growth in 5 per cent; rachitic in 5 per cent; delicate in 5 per cent; delayed menstruation, in 5 per cent; scrofulous, in 3 per cent; and asthenic, in 3 per cent. Roughly speaking, we can say that exophthalmic goiter appeared in an otherwise healthy, sturdy child in only one-fourth of the cases, and second that exanthemata and acute upper respiratory infections probably play the same predisposing rôle that they do in regard to the acquisition of various other diseases of later childhood.

SYMPTOMS AND PHYSICAL SIGNS

The four cardinal signs or symptoms of Graves' disease are: goiter, tachycardia, exophthalmos, and tremor. These may be present in any degree and grouping, and any two or three symptoms may, though rarely, be absent. In 34 of the 50 cases, some mention of these cardinal symptoms was made as shown in Table III.

Of the four cardinal symptoms, those relating to the heart have received the most consistently detailed observation. Some *cardiac sign or symptom* is mentioned in each of the 50 case reports. In 5 cases no mention was made of the heart rate. In 2 of the 45 remaining cases normal pulse rate was specified. In 11 cases either tachycardia or palpitation was mentioned, and of the 33 cases in which a pulse rate was reported, none was below 100 beats per minute. It, therefore, seems reasonable to expect tachycardia in from 90 to 95 per cent of cases of juvenile exophthalmic goiter.

TABLE III.—SEQUENCE OF CARDINAL SYMPTOMS

	Goiter	Exophthalmos	Tachycardia	Tremor
1st symptom noticed	9	8	7	3
2nd symptom noticed	6	5	5	0
3rd symptom noticed	8	4	3	2
4th symptom noticed	0	2	4	2

Other cardiac symptoms were mentioned as follows:

Cardiac symptoms	Per cent of 50 cases
Heaving precordial impulse	30
Enlargement of the heart	26
Pulsating cervical veins and arteries	26
Murmurs	22
"Weak pulse"	12
Accentuated second sound	8
Irregular pulse	6
Thrills	6
Bruits	4
Heart failure	2

These percentages should be taken only as a general indication of the relative incidence of heart symptoms and signs, because the various observers probably did not note the presence or absence of symptoms with equal care and precision.

Thyroid enlargement, as might be expected, was present in 100 per cent of the cases. In only 12 per cent, however, was the goiter definitely described as a marked enlargement. In 4 per cent it was reported as small. In 30 per cent, the right lobe was noted as being larger than the left; in 4 per cent, as being smaller.

Exophthalmos was reported as present in 96 per cent of the cases, and as marked in 22 per cent. In only 4 cases was reference made to a difference in the degree of exophthalmos in the two eyes. The associated eye signs of lid lag (von Graefe), widened apertures (Stellwag), and weakness of convergence (Moebius), were mentioned in so few of the reports that to give the percentages would be entirely misleading. In 1 case, Gagnon's, the exophthalmos was severe enough to produce keratitis and corneal ulcer. This also was 1 of the 2 cases in the series with fatal termination.

Digestive symptoms were observed in only a few cases. Vomiting and anorexia were each noted in 4 cases; polyphagia, diarrhœa, and excessive flatus each in 2 cases; epigastric pressure in 1 case.

The only *respiratory symptom* mentioned with any frequency was dyspnœa on exertion in 20 per cent of the cases.

Some *nervous or psychic symptom* was mentioned in 27 of the 50 cases; but aside from

TABLE IV.—RESULTS OF DIFFERENT TYPES OF OPERATION

Type	Number	Disappearance of symptoms Complete and Partial	No change	Worse
Ligation only	3	3	0	0
Preliminary ligation.	2	0	1	0
Double lobectomy after ligation	1	1	0	0
Single lobectomy after ligation	1	1	0	0
Primary double lobectomy	2	1	0	0
Total operations	9	7	2	0

the report of tremor in 18, irritability in 16, and insomnia in 4 cases, there is a surprising lack throughout the whole series of case reports of systematic evaluation of the nervous system. Almost all of the individual signs and symptoms we are accustomed to look for, such as, restlessness, crying, fatigability, increased reflexes, quadriceps weakness, etc., were mentioned once or perhaps twice, but not oftener.

The same indifference characterized the reporting of *skin symptoms*, but it is of interest to find vitiligo reported in 2 cases. Both patients were 12 years of age.

In the group of 50 cases which we have been considering, the basal metabolic rate has been mentioned only in the 3 cases reported by Heiman and in our 2 cases. Helmholz, however, in his series of 30 cases gives excellent tables of the pre-operative and postoperative metabolic rates. Heiman's 3 cases showed rates of plus 12 per cent, plus 20 per cent, and plus 52 per cent, respectively, before operation. Ours showed highest rates of plus 80 per cent and plus 40 per cent.

TREATMENT AND ITS RESULTS

Excluding consideration of the series of Dinsmore and Helmholz, definite notes on treatment were given for only 29 cases and of results in only 38 of the 50 cases. Thyroid surgery was resorted to in 9 cases, and consisted of a ligation of the superior thyroid arteries alone in 8 cases; a single lobectomy, preceded by a ligation, in 1 case; a double lobectomy, preceded by a ligation in 1 case; a primary single lobectomy in 2 cases, and a primary double lobectomy in 3 cases. None of these 9 cases was made worse by surgery, 1 case showed no change following ligation,

TABLE V.—RESULTS OF DIFFERENT TYPES OF MEDICAL TREATMENT

Form of treatment	No. of cases	Better	No change	Worse
Electricity	8	4	3	1
Digitalis	6	5	1	0
Iodine	4	3	0	1
Arsenic	2	1	1	1
Potassium iodide	2	1	1	0
High caloric diet	2	2	0	0
Tonsillectomy	2	0	0	2
Quinine	2	2	0	0
Iron	2	2	0	0
Venesection	1	1	0	0
Rest	1	1	0	0
Ice bags	1	1	0	0
Steel	1	1	0	0
Ergotin	1	0	1	0

and the 8 others were either partially or wholly improved. A tabulation of operative results is shown in Table IV.

Turning to methods of treatment other than thyroid surgery, a large and interesting variety is encountered. Eight cases were treated by some form of electric current, all before 1887. The drug most frequently used was digitalis, and it was employed in cases reported as early as the '70's. Iodine, curiously, was used in only 4 of the group of 50 cases, including our own, but it was doubtless used in many or all of the series of Dinsmore and Helmholz. Rest, likewise, was specifically cited in only 1 case, but here again it is safe to assume that in nearly all of the 50 cases rest in some degree was employed without, perhaps, a due appreciation of the large rôle it was probably playing in the patient's improvement. It is interesting that in 2 cases in which tonsillectomy was tried as a palliative measure, in full knowledge of co-existing hyperthyroidism, the resulting condition was worse rather than better. In Table V the various forms of treatment and results obtained are shown. Most of the drugs listed were used in combinations of two or three.

SUMMARY AND CONCLUSIONS

In any report of a case or group of cases, the late results almost always rank first in fundamental interest and importance. To follow patients and convince them of the value of returning for periodic examinations, over a period not only of months but of years, is slow and often seemingly thankless work, yet

what an invaluable set of data we would have if we could only know the subsequent clinical history of every one of these children and the effects of the early hyperthyroidism! How many of the patients who were not operated upon and have had spontaneous remissions had recurrences in later life and how many of these recurrences were in the form of adenomatous or parenchymatous goiters? Did thyroidectomy have any apparent adverse effect on the growth, development, fecundity, etc., of the patients? In one of our own cases we feel that we have enlisted the co-operation both of the parents and patient and shall make every effort to continue our observations in order that a subsequent report may be made after a period of years.

In addition to stressing the importance of ascertaining and reporting late results, we also wish to urge a certain uniformity in reporting cases as infrequently observed as these, and to suggest that the schema of Steiner be used as a framework on which to build such reports, so that the early case reports can be included. Certain data, such as basal metabolic studies, details of operative procedures, electrocardiographic studies, etc., will, of course, have to be added. Only by pooling our observations of such rare cases as these can we eventually obtain reasonably reliable statistical data to help us form conclusions rather than opinions.

What, finally, are the opinions we have reached from the observation of our own and the cases we have gathered together from the literature? First, juvenile hyperthyroidism is apparently identical in its symptoms, course, and response to treatment, to the adult syndrome known as exophthalmic goiter. Second, cases of juvenile hyperthyroidism are in the present state of our knowledge, primarily surgical problems, and the sequence of events in their care should be rest, the administration of iodine, operation, rest, and observation under surgical supervision. Third, while we doubt that polar ligation of the superior thyroid arteries is a sufficiently radical procedure to insure a permanent recession of symptoms, we feel that one should be a shade more conservative in the relative amount of thyroid tissue left behind at operation as compared with that left in cases of adult exophthalmic goiter—even risking the necessity of subsequent re-operation, until we have some accurate data on the effect of subtotal thyroidectomy upon human growth and development.

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THE SIGNIFICANCE OF MUCUS-FORMING CELLS IN CARCINOMA OF THE LARGE INTESTINE AND RECTUM[1]

By NORMAN C. OCHSENHIRT, M.D., Rochester, Minnesota
Fellow in Surgery, The Mayo Foundation

MUCUS is a viscid sticky secretion produced by the goblet cells of mucous membranes and by mucous glands. It is found in almost all cylindrical and cuboidal epithelial membranes, such as line the respiratory and gastro-intestinal tracts, (11) and in the mucous glands of these tracts; in the saliva, from the mucus-secreting glands of the mouth, such as the submaxillary and sublingual glands and the mucous glands of the tongue; in the bile, from the mucous glands and the goblet cells of the mucous membrane of the large bile ducts; in the gall bladder from its mucous glands, and in the urine (6).

In the large intestine, most of the cells of the epithelial surface and the mucous glands are goblet cells. Mucus is laid down within these cells in the form of granules or globules of mucigen. These granules eventually swell up to form globular masses which clump together and greatly distend the part of the cell nearest the free border and are extruded as mucus. These goblet cells or mucus-secreting cells are not mere temporary modifications of the ordinary columnar epithelial cells, but are permanently differentiated cells. After discharging their mucus they again form a fresh supply (11).

Bizzozero found that the mucous cells, as well as the protoplasmic cells, arise from undifferentiated elements, but in the embryo only the protoplasmic cell is present; the mucous cell arises from a later differentiation.

Sacerdotti found that mucous cells differentiated early in the embryo of a cow. In a 3.5 centimeter fetus, he found certain cell groups beginning to form and surround a mucus-containing cavity and in a 7 centimeter fetus he found mucous cells in the rectum, and a few in the duodenum and ileum.

Baginsky discovered in a 4 month human fetus that there was slight formation of glands in the colon but that the mucous membrane was composed of flat epithelium. In a 7 month fetus he found well developed glands everywhere and the epithelium cylindrical, often changing to the goblet type. Observations concerning the rectum were similar.

Von der Leyen did not find goblet cells in which mucus could be demonstrated in the colon of a 27 centimeter fetus but they were numerous and distinct in the newborn and in older children.

"By cellular differentiation is meant the structural changes which take place in the evolution of an adult tissue cell" (7).

"The conception that the presence of cellular differentiation is unfavorable to the continued growth of carcinoma cells is based on the unwritten law in general biology, that the power of cellular production is inversely proportional to cellular differentiation. If the law is correct, carcinoma cells which show partial rentiation must of necessity grow less rapidly than carcinoma cells without differentiation" (12).

Robertson states that the appearance of mucus droplets in cells of growths arising from any glandular epithelial structures is a differential characteristic; that it is quite evident that the mucus-producing epithelial cell is a differentiation, and growths from these cells retain with exceeding tenacity this particular characterization.

"The cells of a neoplasm that show practically no tendency to control themselves rapidly infiltrate the adjacent structure and by utilizing the vascular system as a means of metastasis set up colonies in various parts of the body which in turn keep on producing their own kind of cells, finally with fatal result. On the other hand, if the cells of a neoplasm show a marked tendency to control themselves by differentiation, the neoplasm will grow slowly and show very little tendency to metastasize" (3).

Carcinoma that arises from the regenerative cells of glands or secretory epithelium should be termed adenocarcinoma or gland-carcinoma

[1] Abridgment of thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Surgery, 1927. Work done in the Department of Pathologic Anatomy.

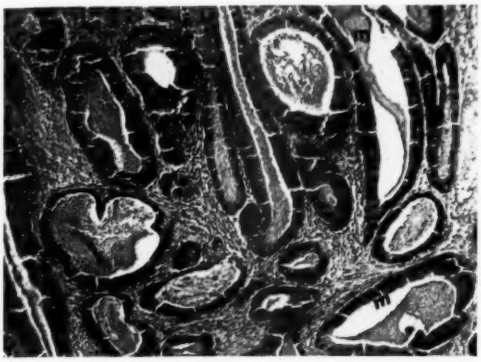

Fig. 1. Colloid carcinoma of ascending colon graded 1 with mucus formation graded 4. Most of the cells show mucus formation with much mucus along the edges of the acini and distention of the acini with colloid material staining lightly with mucus stain, *m*. Some darker staining mucus material is suspended in the colloid. The mucus stains red, the remaining tissue blue. Mucicarmine stain, picric and acetic acid fixation. ×60.

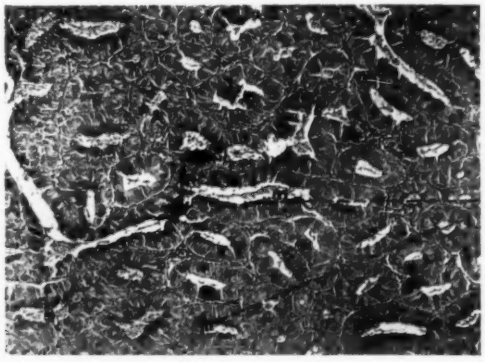

Fig. 2. Section from adenocarcinoma of rectosigmoid graded 2 with mucus formation graded 3. Mucus is seen in many of the cells as large and small globules and also along the free surfaces of the cells and in the acini, *m*. Mucicarmine stain; picric and acetic acid fixation. ×60.

because whenever differentiation takes place it is usually toward a glandular or secretory type of epithelium. Carcinoma of the large intestine and rectum are nearly always adenocarcinoma with a tendency toward the formation of mucus. The mucus originates in the epithelial cells of the carcinoma. Droplets of mucus are seen arising within the cytoplasm of epithelial cells of the goblet type, and in adenocarcinoma mucus is found within the acini. Epithelial cells containing these droplets can practically always be found in the immediate vicinity of extracellular mucus.

In this study, sections were made from 188 cases of carcinoma of the large intestine and rectum. The sections were taken from fresh operative specimens and from pathological museum specimens which had been preserved in 10 per cent formalin for from 2 to 30 months. The sections were fixed in alcohol and acetic acid when received at the time of operation, and in picric and acetic acids when obtained from the museum (5). All sections were stained with mucicarmine according to the following technique: (1) fix fresh specimens in alcohol and acetic acid for 24 to 48 hours; fix older specimens (preserved in formalin) in picric and acetic acids for 24 to 48 hours; (2) wash in running tap water for 24 hours; (3) dehydrate in 80 per cent alcohol for 6 hours; (4) dehydrate in 95 per cent alcohol for 4 hours; (5) dehydrate in absolute alcohol for 6 hours; (6) place in equal parts of toluol and paraffin in an oven at 52 degrees C. for 1 hour; (7) embed in paraffin in an oven for 2 hours; (8) cut sections about 8 microns thick; (9) stain with alum hæmatoxylin for 3 minutes; (10) decolorize with acid alcohol; (11) immerse in an aqueous solution of lithium carbonate for 2 or 3 minutes to bring out the blue color; examine the section under the microscope to determine the depth of the stain at this stage; (12) wash in water; (13) stain with mucicarmine for from 10 to 20 minutes; examine under the microscope to determine the depth of the stain and the length of time of staining necessary to make the differentiation clear; (14) rinse in water; (15) dehydrate in 95 per cent alcohol; (16) clear with acetone for 5 minutes; (17) clear with carbolxylol composed of 1 part of phenol crystals and 3 parts of xylol; (18) clear with xylol; and (19) mount in Canada balsam. The mucicarmine stain deteriorates rapidly and must be freshly prepared every few days. It is prepared in the following manner:

A mixture of carmine, 1 gram, aluminum chloride, 0.5 gram, and distilled water, 2 cubic centimeters is heated under a small flame for

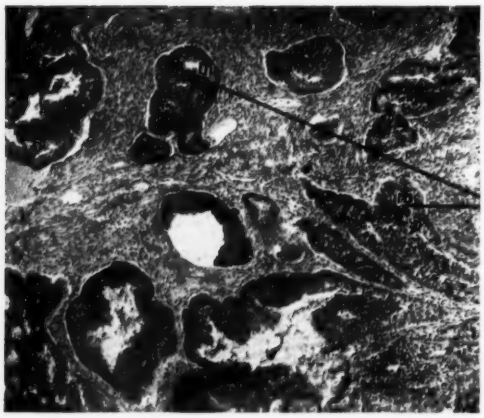

Fig. 3. Section from adenocarcinoma of the rectosigmoid graded 3 with mucus formation graded 2, showing mucus as large droplets in the cells, along the free surfaces of the cells, with very little in the acini, *m*. Mucicarmine stain; picric and acetic acid fixation. Mucus stains a vivid red in marked differentiation to the rest of the tissue which stains blue. ×60.

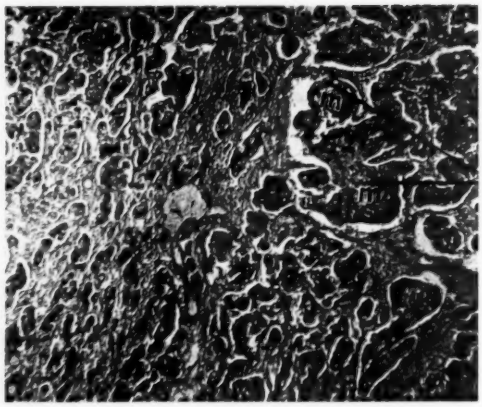

Fig. 4. Section from carcinoma of the sigmoid graded 4 with mucus formation graded 1, showing mucus formation in few cells which contain mucus globules, *m*. Mucicarmine stain; alcohol and acetic acid fixation. Mucus stains red in contrast to the other tissue. ×60.

2 minutes and then made up to 100 cubic centimeters with 50 per cent alcohol. It is then ready for use. Mucicarmine stains mucus and mucus-containing tissue a vivid red in marked contrast to the surrounding tissue which is stained more or less blue.

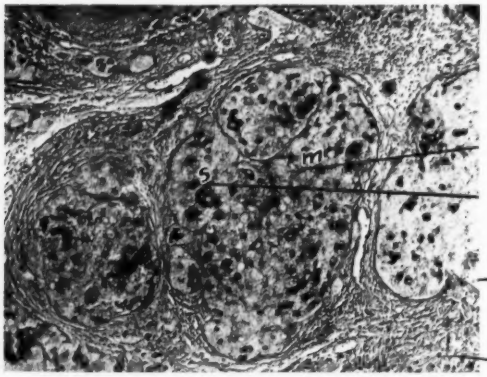

Fig. 5. Section from colloid carcinoma of the cæcum graded 4 with mucus formation graded 4. Large areas of colloid which take the mucus stain faintly with areas of typical mucus staining material scattered throughout these areas, *m*, are shown. Most of the cells are of the signet-ring type, *s*, and are filled with and surrounded with mucus, which takes the typical carmine stain. Mucicarmine stain; picric and acetic acid fixation. ×60.

Each case was graded microscopically by Broders according to his method of grading malignancy, and a system was devised for the purpose of grading the number of mucus-forming cells in carcinoma of the large intestine and rectum (Table I). Mucus was graded 1 when from practically none to 25 per cent of the cells seemed to be involved in the secretion of mucus as evidenced by the mucous globules contained in the cell and the mucus extruded therefrom and lying in the im-

TABLE I.—COMPARISON OF THE GRADING OF THE AMOUNT OF MUCUS TO THE MALIGNANCY IN ALL CASES OF CARCINOMA

Malignancy, grade	Cases	Mucus formation, grade	Cases	Per cent
1	16	4*	16	100.0
		1	1	0.9
		2	28	27.4
2	102	3	72	70.5
		4	1	0.9
		1	15	26.7
		2	34	60.6
3	56	3	5	8.9
		4	2	3.5
		0	2	14.3
4	14	1	10	71.4
		4	2	14.3

*Figure 1.

TABLE II.—COMPARISON OF THE GRADING OF THE AMOUNT OF MUCUS TO THE GRADING OF MALIGNANCY IN COLLOID CARCINOMA

Malignancy, grade	Cases	Mucus formation, grade	Cases	Per cent
1	6	4	6	100.0
2	8	3	5	62.5
		4	3	37.5
3	6	3	4	66.6
		4	2	33.3
4*	2	4	2	100.0

*Signet-ring type.

mediate vicinity of the cells along its free border; graded 2 when from 25 to 50 per cent of the cells were producing mucus; graded 3 when from 50 to 75 per cent of the cells were producing mucus, and graded 4 when from 75 to 100 per cent were producing mucus.

Table I shows that in almost all of the cases the percentage of mucus-secreting cells is inversely proportional to the grade of malignancy. This conforms to Broders' basis of grading malignancy on cell differentiation, the formation of the secretion of mucus being evidence of differentiation (Figs. 1 to 4).

The so-called colloid carcinoma is an exception. There were 22 colloid carcinomata in this series (Table II). In the less malignant type of colloid carcinoma there does not seem to be an increase in the number of mucus-forming cells as compared to those found in an adenocarcinoma of the same grade. However, the amount of mucus is increased, as the staining indicates. This is probably due to increased activity on the part of the mucus-forming cells. The acini are greatly distended and contain colloid-like material which takes the mucus stain poorly or not at all. This colloid-like material contains small suspended particles which take a typical mucus stain and appear to be true mucus. Wells believes that the mucin of colloid carcinoma of the gastro-intestinal tract is the same as normal mucin, from the same source, thickened by partial absorption of water from the pressure of retention in a closed cavity, and mixed with larger or smaller quantities of other proteins derived from cell degeneration or from vascular exudates. In colloid carcinoma of the higher grades, especially in those graded 4, mucus seemed to be greatly in excess. Parham found that the signet-ring colloid carcinoma was the most malignant type of colloid carcinoma. Such was the case in this series: the only cases of singet-ring carcinoma were those in which the malignancy was graded 4 (Fig. 5). No goblet cells or cells which resembled the typical mucus-secreting cells were found, yet almost all of the cells were of the signet-ring type and were filled with mucus.

CONCLUSIONS

1. The presence of mucus in carcinoma of the large intestine and rectum is the result of partial differentiation of the carcinoma.
2. The more malignant the carcinoma, or the less the extent of differentiation, the less numerous are the mucus-secreting cells, and vice versa.
3. The number of mucus-secreting cells in the carcinoma is inversely proportional to the grade of malignancy.

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VAGINAL HERNIA[1]

By JAMES C. MASSON, M.D., F.A.C.S., and HAROLD E. SIMON, M.D., Rochester, Minnesota

A PORTION of the abdominal contents which pushes a peritoneal sac through an opening in the pelvic floor and presents itself in the vagina constitutes a vaginal hernia. The condition is very rare and is frequently not recognized clinically. Often only after the failure of one or more attempts at the surgical repair of a supposed cystocele or rectocele is the true nature of the condition discovered.

Five cases of vaginal hernia, exclusive of the postoperative type, have been observed at the Mayo Clinic and have been made the basis of this discussion.

LITERATURE

The number of cases of vaginal hernia reported in the literature is surprisingly small. Among the first cases reported, according to Barker and Sweetser, is one by Garengeot in the early part of the eighteenth century and another by Sir Astley Cooper in 1804. Sweetser, in 1919, reported one case and discussed the occurrence and the various types of vaginal hernia. He also considered in some detail the differential diagnosis. Miles, in 1926, in a critical review of the literature, analyzed 9 cases which had been reported with sufficient detail and accuracy to make them of value, and to these he added the reports of 2 cases which he had observed personally. He discussed the various types of pelvic hernia and suggested an excellent classification of them on an anatomical basis.

CLASSIFICATION

In Miles' classification, all hernias which pass through the pelvic floor are classed as pelvic hernias. These are subdivided, according to their point of egress: pudendal hernias present in the labia; perineal hernias in the perineum, and vaginal hernias in the vagina.

Miles has subdivided vaginal hernia into the anterior and posterior varieties depending on the relationship which the sac bears to the uterus. He does not group postoperative vaginal hernias separately. They form a distinct type and should be included in a third subdivision in this classification.

CASE REPORTS

Case 1. A woman, 44 years old, who had been pregnant 4 times, had noticed soreness in the right lower quadrant of the abdomen and pain radiating down the right leg ever since the last pregnancy, 6½ years previous to examination at the Mayo Clinic. These symptoms had gradually become more severe and were aggravated when she was on her feet.

There were multiple fibromyomata of the uterus and a well-marked vaginal hernia through the cul-de-sac of Douglas. Total abdominal hysterectomy was performed, both tubes and ovaries were removed and the sigmoid was utilized to obliterate the cul-de-sac. Convalescence was uneventful and after she was dismissed, there was no recurrence of the hernia

Case 2. The patient, a woman aged 42 years, who had been pregnant 5 times, was examined in 1919. In 1907, perineorrhaphy had been performed on account of a supposed rectocele. The condition recurred and 6 months later, uterine suspension was performed, the cervix was amputated, and another perineorrhaphy was performed. Again there was recurrence. Since the onset of the first symptoms in 1907, there had been attacks of abdominal pain and distention which had recently become more severe and had been accompanied by vomiting.

The patient was moderately obese. The uterus was loosely attached to the anterior abdominal wall. Externally the perineum was in good condition, but the muscles had separated and provided no support. A mass about 10 centimeters in diameter pushed the posterior vaginal wall forward and presented at the vulva. There was a cystocele of moderate size.

Partial vaginal hysterectomy was performed, the lower half and the interior of the uterus being removed. The hernial sac was isolated and excised, and its stump, together with the bladder, was sutured to the fundus of the uterus which had remained adherent to the anterior abdominal wall. The operation was completed as a perineorrhaphy. Two years later the patient was in good health. There was slight bulging into the vagina which caused her no inconvenience. The abdominal symptoms had been entirely relieved.

Case 3. A woman, 65 years of age, who had been pregnant 10 times, complained of a mass which had protruded from the vagina for 5 years. Supports had been unsatisfactory and irritating.

The patient weighed 148 pounds. Protruding from the vagina was a large mass which consisted of the uterus and a tumor about 10 centimeters in

[1] Read before the Western Surgical Association, Omaha, Nebraska, December 8 to 9, 1927.

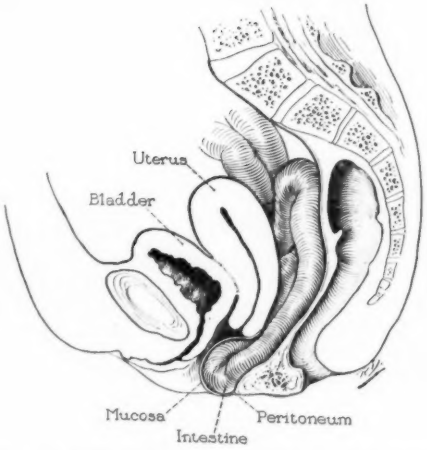

Fig. 1. Longitudinal section through the pelvis showing a posterior vaginal hernia.

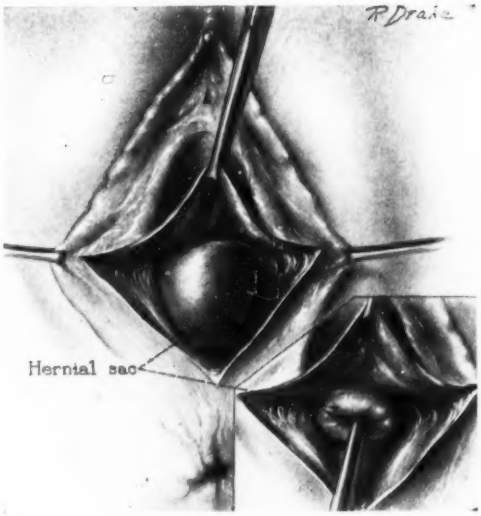

Fig. 2. Hernial sac as it appears after the elevation of the posterior vaginal flap.

diameter which pushed the posterior vaginal wall forward. The rectum formed part of the mass but when this was pushed back the major portion of the mass remained.

A two-stage operation was performed. The abdomen was opened through a low median line incision and the uterus was firmly fixed to the abdominal wall. Appendectomy was also performed. Three weeks later a posterior vaginal flap was dissected high up and the hernial sac isolated and opened. Its contents, loops of the small intestine, the rectum, and the sigmoid, were replaced in the abdomen. The excess portion of the sac was resected and the opening into the abdomen was closed by a spiral suture. Perineorrhaphy was performed in the usual manner. Convalescence was uneventful. Pelvic examination at the time of dismissal disclosed no bulging of the posterior vaginal wall.

CASE 4. The patient, a woman aged 39, had 2 children aged 8 and 10 years, respectively. Eight years previous to examination, an operation for a supposed prolapse had been performed and the uterus fixed to the anterior abdominal wall. The symptoms recurred as soon as the patient stood up. Since then the condition had become progressively worse and for 4 years a mass had protruded beyond the vulva.

Examination disclosed a complete uterine prolapse and marked cystocele. There was a large mass about 25 centimeters in diameter which pushed the posterior vaginal wall forward and protruded from the vulva. The rectum could be isolated from this mass. A diagnosis of complete uterine prolapse with marked cystocele and rectocele, and posterior vaginal hernia was made and an operation was advised. A Mayo vaginal hysterectomy was performed and both tubes and the left ovary were removed. A plastic closure was made, completely obliterating the vaginal canal by lateral approximation with interrupted sutures of chromic catgut. Convalescence was uneventful and the patient was dismissed with the wound healed.

CASE 5. The patient, a woman aged 57, had been married for 31 years previous to examination at the Mayo Clinic. She had had 3 children and 1 miscarriage. Following the birth of the youngest child, in 1904, a protrusion from the vagina appeared which was noticeable when the patient strained or stood but which disappeared when she lay down. In 1906, the left ovary and the appendix were removed and internal shortening of the round ligaments and perineorrhaphy were performed. Three years after this operation, there had been recurrence of the protrusion, so marked that it interfered with walking. In 1913, the Kocher operation for prolapse was performed, but 3 months later the protrusion suddenly reappeared and since then has gradually grown larger. There had been backache at times.

On examination, in 1927, the uterus was found to be in good position but there was extensive bulging of the posterior vaginal wall, more marked when the patient stood. The perineum was in good condition. At operation a flap was dissected free from the posterior vaginal wall and from a thin-walled sac extending down in the median line along the anterior wall of the rectum; this sac was identified as peritoneal. It was apparent that the protrusion was caused by a posterior vaginal hernia. There was very little rectocele. The sac was dissected free as far up as possible and a high perineorrhaphy performed below it. The abdomen was opened and the

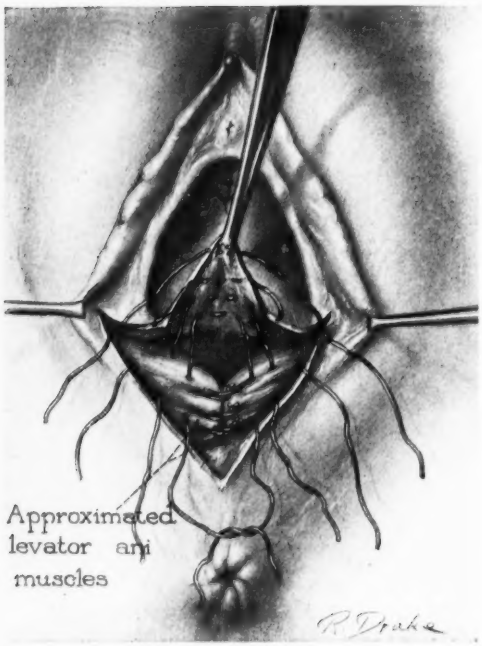

Fig. 3. Repair of the perineum after the disposal of the hernial sac.

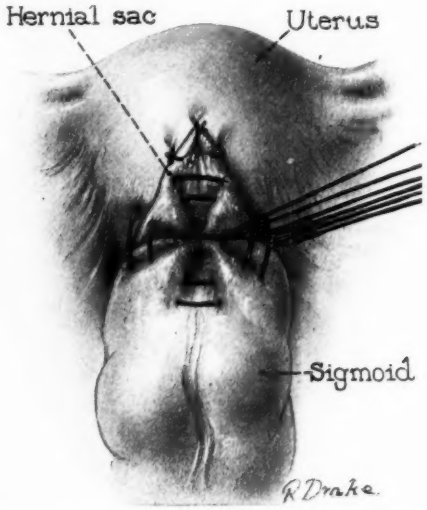

Fig. 4. Obliteration of the cul-de-sac of Douglas by means of purse-string sutures.

hernial sac, which was posterior to the uterus and emerged through or opened into the cul-de-sac of Douglas, was inverted and sutured to the posterior surface of the wall of the uterus. The cul-de-sac was obliterated by a series of purse-string sutures, and the operation completed by suturing the uterus into the abdominal wall. Convalescence was uneventful and when the patient was dismissed a month later there had been no recurrence.

SYMPTOMS AND DIAGNOSIS

The symptoms of vaginal hernia are not characteristic and frequently do not suggest the correct diagnosis, which may not be made until the peritoneal sac is discovered when the flap of vaginal mucosa is dissected upward preparatory to perineorrhaphy. The patient has usually been pregnant but may never have borne children. The presence of a mass inside the vagina or protruding beyond the vaginal orifice usually causes the patient to seek medical attention. The symptoms frequently date from a severe strain or childbirth and the mass tends to become progressively larger. Unless complicated by adhesions, strangulation, or the presence of a neoplasm, the hernia reduces spontaneously when the patient lies down, but promptly recurs on coughing, straining, or standing. When the hernia is large it may interfere with walking.

Frequently one or several surgical attempts have been made to correct this condition. However, if its true nature has not been recognized, which is often the case, and it has been treated as a cystocele or rectocele, it promptly recurs when the patient first stands. Recurrence under these circumstances is the most suggestive symptom of which the patients may complain.

On superficial examination a vaginal hernia is not readily differentiated from a rectocele or a cystocele but a more careful examination will usually reveal its true nature. In some cases the perineum is normal, but since the majority of the patients have been pregnant a number of times there is usually relaxation and, frequently, laceration. The mass may present within the vaginal orifice or it may project beyond it, depending on the size of the hernia, which is often much larger than the average cystocele or rectocele. If the contents of the sac include a portion of the small or large intestine, manual reduction is

often accompanied by a gurgling sound or sensation produced by the gas and liquid in the intestines and the mass may be rendered tympanitic to percussion by the gas in the included bowel. While any or all of these characteristics may be lacking, there is one constant and typical sign of posterior vaginal hernia which is disclosed on rectal examination. When the hernia is in the vagina the finger introduced into the rectum will readily demonstrate that the bulging of the rectum into the vagina, no matter how marked, constitutes only a small portion of the mass. Anterior vaginal hernia may be distinguished from cystocele by the introduction of a sound into the bladder.

While displacement of the pelvic organs is not necessarily part of the picture in vaginal hernia it is rather common and varying degrees of rectocele, cystocele, prolapse, or uterine inversion may be associated with it.

Complications in cases of vaginal hernia are rare. Strangulation is uncommon because the neck of the sac is usually very large in proportion to its size and there is little chance for constriction to occur even in the event of pregnancy. Barker's case developed strangulation which recurred a number of times, associated with symptoms of intestinal obstruction. In Case 2 in the present series there were symptoms probably due to partial strangulation which did not recur after the repair of the hernia.

Conditions which occasionally simulate vaginal hernia are cysts and tumors of the vagina. They are extremely rare, however, and usually may be readily differentiated by careful examination. Miles has pointed out that cysts of Gartner's duct are especially confusing because they may be reduced on pressure, the fluid returning along the duct to a cyst of the parovarium in the broad ligament.

ANATOMICAL CONSIDERATION

The posterior type of vaginal hernia is the more common, occurring about sixteen times as frequently as the anterior type. In the posterior type the sac emerges from the abdomen through the cul-de-sac of Douglas, and dissects downward between the anterior wall of the rectum and the posterior wall of the vagina (Fig. 1). As the vaginal wall is pushed forward it is everted and drops down to form a soft pendulous mass, which, if sufficiently large, protrudes from the vulva.

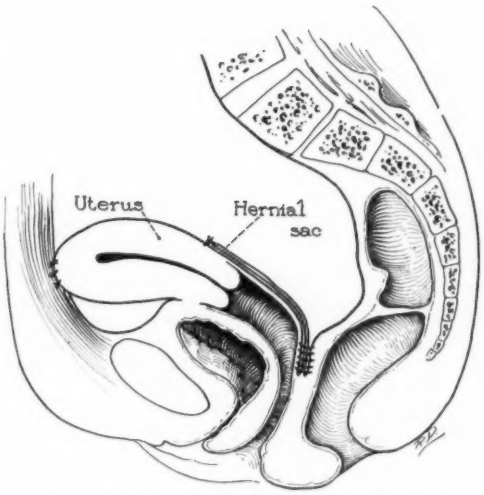

Fig. 5. Completion of the combined type of operation for the repair of the posterior vaginal hernia.

The pelvic floor, according to Thompson, is a thick compact mass traversed by clefts or faults, the walls of which are normally in contact but which open to allow material to pass through them. Symington states that in the mesial plane the pelvic floor is, as a rule, about 2.5 centimeters thick. Laterally it varies but is always thicker than in the middle; near the lateral wall of the pelvis it is from 5 to 7.5 centimeters thick. Muscles and their fascial coverings compose this floor. The most important of these muscles are the levator ani and coccygeus, representing in the human subject two of the tail muscles of lower animals. The part of the levator muscles arising from the posterior surface of the os pubis passes backward lateral to the urethra, vagina, and rectum, to its insertion in the sacrum and coccyx. Fibers passing across between the urethra and vagina and the vagina and rectum constitute the pubo-urethralis and pubovaginalis, respectively. The levator ani is, according to Derby, one of the most variable muscles in the body. A congenital weakness or absence of these inter-

communicating fibers, provides the predisposing condition in the development of vaginal hernia in the event of severe strain. Such a strain comes during pregnancy when the tissues of the pelvis become lax and congested and the trauma of delivery is superimposed. From a consideration of the relative strength of the pelvic floor in its median and lateral portions it will be readily seen that these hernias are likely to occur in the median line, and but rarely, if ever, on either side unless they pass through or entirely lateral to the levator muscles as in the pudendal and perineal type of pelvic hernia.

Anterior vaginal hernias emerge from the abdomen anterior to the uterus and follow downward in the plane of cleavage between the anterior vaginal wall and the bladder.

The coverings of these hernias consist only of the vaginal mucosa and the peritoneum. The contents are, in most cases, portions of the small intestine but in a few instances large intestine has been found in them. Occasionally, when there has been a pelvic infection, adhesions form within the sac and about the neck in such a manner that the intestine cannot possibly pass into the hernia and the contents consist of fluid only.

ETIOLOGY

Available data are insufficient for drawing definite conclusions in regard to the etiology of vaginal hernia. It is plausible that congenital weakness of the muscles forming the pelvic floor may be an essential predisposing factor, especially when vaginal hernia is found in nulliparous women. In the majority of cases, however, the hernia is acquired and follows pregnancy or some unusual strain, or occasionally occurs with ascites or a large abdominal tumor. In these cases, however, it is impossible to say that there had not been congenital weakness or faulty development of the muscles of the pelvic floor which might have been the essential predisposing factor. If congenital weakness is not presupposed to be essential, it is difficult to explain why there are not more cases of vaginal hernia since the other factors, namely, pregnancy, unusual strain, and abdominal tumor or ascites, occur so commonly.

TREATMENT

Vaginal hernia should be treated surgically. Untreated, the hernia tends to enlarge and the use of palliative measures, such as supports of various types, has proved unsatisfactory. No uniform procedure has been adopted in treatment because vaginal hernia occurs so seldom and because co-existing malpositions of the pelvic organs vary so greatly in different cases. However, certain well-recognized principles governing the treatment of hernia in general must be adhered to in dealing with vaginal hernia. There are three things that must be accomplished: isolation of the sac, disposal of the sac, and repair of the defect at the point of egress of the hernia from the abdomen. The means by which these ends can best be accomplished depend somewhat on the condition and position of the pelvic organs.

Isolation of the sac. The sac may be most successfully isolated through a vaginal incision. Sometimes a vaginal flap has been dissected free before the hernia is discovered and it remains only to complete the isolation of the sac through this incision. If vaginal hernia has been diagnosed clinically, the usual incision for the repair of a rectocele or cystocele, depending on whether the hernia is anterior or posterior, should be made, and the sac isolated (Fig. 2).

Disposal of the sac. The hernial sac may be disposed of either through the vaginal or the abdominal route. When the operation is performed through a vaginal incision, the contents of the hernia are pushed well up into the abdomen, the neck of the sac is ligated, and the superfluous portion excised. If a combined type of operation is to be used the hernia is reduced, the sac pushed up into the abdomen (Fig. 2 inset), and the repair of the perineum completed in the usual manner (Fig. 3). Then, when the abdomen is opened the sac is completely inverted and sutured to the posterior wall of the uterus, or sometimes the excess tissue of the sac is excised, and the opening closed by a purse-string suture.

Repair of the defect at the point of egress of the hernia. If the neck of the sac is easily accessible, repair of the defect at the point of egress of the hernia may occasionally be accomplished through the vaginal incision.

When the sac is disposed of in this manner, the levatores ani are drawn together and the operation completed as a high perineorrhaphy. However, repair of the defect in the pelvic floor is most satisfactorily carried out through an abdominal incision. A series of purse-string sutures is utilized to obliterate the cul-de-sac of Douglas (Fig. 4) when the hernia is posterior, and the vesico-uterine space when the hernia is anterior to the uterus. In some cases the colon may be utilized to cover over the weak point in the pelvic floor. The operation may then be completed by the correction of any uterine displacement that may be present. When the patient has passed the child-bearing age, the uterus may be fixed into the anterior abdominal wall (Fig. 5).

Special cases. Vaginal hernias in association with certain types of pelvic displacement require special types of repair. In cases of posterior vaginal hernia associated with uterine prolapse of advanced degree, the the patient being near or past the menopause, an operation may be performed entirely by the vaginal route. A vaginal flap is dissected free as preliminary to perineorrhaphy; the hernial sac is isolated and disposed of as described; a Mayo vaginal hysterectomy is performed; the broad ligaments are sutured together well posteriorly, and the operation is completed as a perineorrhaphy, or the vagina may be obliterated with approximating sutures of chromic catgut. Two cases in this series were treated in this manner.

The abdomen may be explored preliminary to the vaginal operation when abdominal complications make it desirable. The neck of the sac is closed by a series of purse-string sutures and the cul-de-sac of Douglas is obliterated at the same time. Isolation of the sac and removal of the superfluous tissue, as well as any plastic operation on the vagina, may be accomplished as a second stage either at the time or later.

When the first stage of the repair is performed through a vaginal incision and the second stage is to be performed through an abdominal one, the second stage should be carried out at the same time or before the patient is permitted to be up, otherwise these hernias usually recur.

SUMMARY

Vaginal hernias are rare. A surprisingly small number have been reported in the literature and only 5 have been observed at the Mayo Clinic.

The symptoms are not characteristic and it is only rarely that a diagnosis is made previous to operation. Frequently, the true nature of the condition is overlooked even at operation, and it may be only after the failure of one or repeated operations that the correct diagnosis is made. Careful examinations will eliminate these errors.

The etiology is not definitely known but it seems plausible that congenital weakness of the muscles which form the pelvic floor may be the predisposing factor in the production of many, if not all, of the cases.

The treatment is surgical and, while it has not been standardized because of the variations in the complicating pelvic conditions, the principles of an adequate procedure are well defined and correspond to those governing the treatment of hernias elsewhere.

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PYURIA IN CHRONIC UNCOMPLICATED PROSTATITIS[1]

By ALEC HORWITZ, M.D., Rochester, Minnesota
Fellow in Surgery, The Mayo Foundation
AND
WILLIAM H. VON LACKUM, M.D., Rochester, Minnesota
Section on Urology, Mayo Clinic

THE histories of 500 cases of chronic prostatitis uncomplicated by disease of the upper part of the urinary tract or by urethritis, chosen at random from the files of the Mayo Clinic, were studied in order to determine the incidence of pyuria. The microscopic examination of the secretion in such cases, the number of pus cells in each high-power field, the presence of degenerated leucocytes and their clumping, all enter into the diagnosis.

The grading of prostatitis on the number of pus cells in each field (centrifugalized) is as follows: normal, 1 to 5 cells; prostatitis graded 1, 5 to 15 cells; prostatis graded 2, 15 to 50 cells; prostatitis graded 3, 50 to 150 cells, and prostatitis graded 4, 150 cells or more.

The grading of pyuria on the number of pus cells in each high-power field is as follows: pus graded 1, 1 to 20 cells; pus graded 2, 20 to 50 cells; pus graded 3, three-fourths of high-power field filled with pus cells; pus graded 4, whole field packed with pus cells. In male patients, urine was considered normal if there was no pus. However, the limits of 1 to 10 pus cells in each high-power field is usually considered negligible.

The cases for study were divided into four arbitrary groups: (1) those in which clear urine (no pus cells) was present; (2) those in which there was pus graded 1, 1 to 10 cells in each field (a negligible quantity); (3) those in which pus was graded 1 with 10 to 20 cells in each field (mild pyuria), and (4) those in which pus was graded 2 or more (marked pyuria). Only cases of chronic prostatitis graded from 2 to 4 were studied. The incidence of venereal disease and the relation of chronic prostatitis with and without such

TABLE I.—INCIDENCE OF PYURIA

Prostatitis	Cases	Gonorrhœa		Clear urine		Pus graded 1; 1 to 10 cells		Pus graded 1; 10 to 20 cells		Pus graded 2 or more	
Grade		Cases	Per cent	Cases	Per cent	Cases	Per cent	Cases	Per cent	Cases	Per cent
2	160	85	53.1	50	31.2	98	61.3	7	4.4	5	3.1
3	182	101	55.5	62	34.0	101	55.6	10	5.5	9	4.9
4	158	83	52.5	55	34.8	78	49.4	11	6.9	14	8.8
.....	500	269	53.8	167	33.4	277	55.4	28	5.6	28	5.6

TABLE II.—CASES IN WHICH THERE WAS A HISTORY OF GONORRHŒA

Prostatitis	Cases	Clear urine		Pus graded 1; 1 to 10 cells		Pus graded 1; 10 to 20 cells		Pus graded 2 or more	
Grade		Cases	Per cent	Cases	Per cent	Cases	Per cent	Cases	Per cent
2	85	23	27.7	52	61.1	6	7.1	4	4.7
3	101	29	28.7	58	57.4	7	6.9	7	6.9
4	83	23	27.5	44	53.0	5	6.0	11	13.2
.....	269	75	27.8	154	57.2	18	6.7	22	8.2

[1] Submitted for publication January 14, 1928.

TABLE III.—CASES IN WHICH THERE WAS NO HISTORY OF GONORRHŒA

Prostatitis	Cases	Clear urine		Pus graded 1; 1 to 10 cells		Pus graded 1; 10 to 20 cells		Pus graded 2 or more	
Grade		Cases	Per cent	Cases	Per cent	Cases	Per cent	Cases	Per cent
2	75	27	36.0	46	61.3	1	1.3	1	1.3
3	81	33	40.7	43	53.1	3	3.7	2	2.5
4	75	32	42.7	34	45.3	6	8.0	3	4.0
.....	231	92	39.8	123	53.2	10	4.3	6	2.6

TABLE IV.—RELATION OF VENEREAL DISEASE TO CONDITION OF URINE

Prostatitis	Clear urine			Pus graded 1; 1 to 10 cells			Pus graded 1; 10 to 20 cells			Pus graded 2 or more		
Grade	Total	Cases*	Per cent	Total	Cases*	Per cent	Total	Cases*	Per cent	Total	Cases	Per cent
2	50	23	46.0	98	52	53.1	7	6	86	5	4	80
3	62	29	46.7	101	58	57.4	10	7	70	9	7	78
4	55	23	41.8	78	44	53.4	11	5	46	14	11	79

* With history of venereal disease.

disease to pyuria was also noted. The results of the study are shown in Tables I to IV.

CONCLUSIONS

1. A history of gonorrhœa was elicited in a little more than half of the cases of prostatitis. The fact that the incidence in the three grades of prostatitis (grades 2, 3 and 4) was about the same, would indicate that gonorrhœa bears no relation to the severity of prostatitis.

2. In about one-third of the cases the urine was clear, and in about 89 per cent it was either normal or almost normal. In 11 per cent there was either mild or marked pyuria; the more severe the prostatitis the more severe the pyuria.

3. In about 15 per cent of the cases in which gonorrhœa was associated, there was either mild or marked pyuria.

4. In the cases of mild pyuria the more severe the prostatitis the less frequent the incidence of gonorrhœa (86 per cent in cases graded 2 and 46 per cent in cases graded 4). The number of cases, however, is too few in this group to warrant definite conclusions.

5. In the cases of marked pyuria, gonorrhœa was present in approximately 80 per cent regardless of the severity of the prostatitis.

INFECTIVE OSTEOMYELITIS

By ROBERT KENNON, M.D., F.R.C.S., Liverpool, England
Lecturer in Practical Surgery, University of Liverpool

INFECTIVE osteomyelitis may be defined as a septicæmia which metastasizes in bone. The term "schoolboy's disease" is metaphorically descriptive of the usual age and sex of the victim. Commonly an obscure history of ill-health, colds, boils, tonsillitis, pneumonia, or general rheumatic pains will precede the mild sprain which localizes the disease in the end of a long bone and, since few schoolboys especially among the poorer classes, willingly forego their games for a simple cold, certain school authorities have found it advisable and provident to insure against the disastrous consequences and sequelæ of this disease: a history of trauma is, however, frequently absent and osteomyelitis in association with simple fracture is a rarity.

Our professional objective in dealing with acute osteomyelitis is to avoid, by means of early diagnosis and prompt surgical treatment, prolonged suffering and ultimate physical deformity. Generally, even in neglected cases, life can be saved but it must be borne in mind that, in fulminating cases, septicæmia will cause death, however careful the operator may be to establish free drainage; further, with pyæmic cases, the danger of pericarditis must not be overlooked.

The primary object of the present paper is to define the early diagnostic signs of osteomyelitis. By the aid of these, the development of a focus can be successfully checked by immediate surgical interference and thereby much suffering can be averted.

THE PRIMARY OSSEOUS FOCUS OF OSTEOMYELITIS

Acute osteomyelitis starts in the shaft of a long bone in an area, sometimes termed the metaphysis, immediately beneath the epiphyseal cartilage. It occurs but rarely in the epiphysis proper, so that the term "epiphysitis" is a misnomer for the acute disease and, in my opinion, this term should likewise be used only with great reserve in tuberculosis. The primary focus of osteomyelitis is almost without exception within the cancellous bone, from which position it spreads with variable rapidity and extent to the bone marrow and to the periosteum; finally, the infection may involve by extension the intramuscular planes, subcutaneous tissues, and contiguous joints. Since the disease always begins in the center of a bone, the use of the term "periostitis" in this condition should be discontinued; it conveys nothing but an entirely erroneous idea of the disease and suggests inadequate treatment.

The earliest characteristic symptom of acute osteomyelitis is pain and tenderness on pressure with one finger over the end of a long bone—briefly describable as "one-finger rheumatism of bone"; this pain is severe in character, it renders sleep impossible, and its onset is associated with high temperature, frequently preceded by a rigor. These few physical signs are certainly diagnostic of the onset of osteomyelitis and, if operative procedure follows promptly, the ravages of chronic bone disease will be averted in all moderate infections. At this early stage of the infection, negative radiological findings are the rule, and there is no doubt that X-ray examination of cases of acute osteomyelitis within the first 48 hours is often a waste of valuable time and consequently a danger to the sufferer's limb and life.

It must be emphasized that swelling is a late symptom; it appears only after 2 or 3 days, when the central abscess has tracked through the vascular channels to the periosteum and has formed the subperiosteal pocket. This fact is of importance for differential diagnosis since it will be recalled that the onsets of pain, tenderness, and swelling are synchronous in acute rheumatism.

So frequently are the symptoms of this disease misinterpreted during its early stages and false hopes raised by a negative radiological report that I feel it is of importance to describe accurately the most constant positions of "one-finger" pain and tenderness

with respect to each of the long bones, in order that clinicians may subject these positions to digital pressure in all dubious cases of "rheumatism." Probably none of the following observations is essentially original; many of them are confirmations of opinions by various teachers and writers on this subject but, so far as I am aware, they have not hitherto been recorded systematically. Ample proofs that these points of maximal tenderness are of reasonable constancy have been obtained also from the examination of museum specimens and of roentgenograms of chronic cases.

MAXIMAL POINTS OF TENDERNESS IN EARLY CASES OF ACUTE OSTEOMYELITIS—UPPER EXTREMITY (FIGS. 1 AND 2):

1. The antero-internal aspect of the neck of the humerus.
2. The posterior surface of the lower end of the humerus above the epiphyseal line.
3. The posterior surface of the upper end of the ulna.
4. The anterior surface of the lower end of the radius above the epiphyseal line.

LOWER EXTREMITY (FIGS. 5 AND 6):

1. The antero-internal aspect of the neck of the femur.
2. The posterior aspect of the lower end of the femur above the epiphyseal line.
3. The antero-internal aspect of the upper end of the tibia below the epiphyseal line.
4. The posterior aspect of the lower end of the tibia above the epiphyseal line.

The last is the most common situation for osteomyelitis in the whole body and, in view of the liability of the ankle to trauma during school life, memorization of this site and recollection of the etiology and symptoms will obviate many mistakes and disasters.

DIAGNOSTIC VALUE OF RADIOLOGICAL EXAMINATION IN EARLY OSTEOMYELITIS

It has already been indicated that, in the majority of cases of acute osteomyelitis during the first week, radiological examination is a waste of valuable time and may prejudice the patient's life. There is, however, no doubt that, if, at the end of 48 hours, the case has developed a small local swelling associated with pain and tenderness over the end of the bone, the radiologist—by examining the minute details of prints of the limb taken from different positions—will be able to demonstrate, by the slight roughening of the osseous surface, the exact position in which the central abscess makes its exit; such information is clearly of decided value to the operator. If, on the other hand, marked radiological changes in the bone are evident within the first 48 hours after the discovery of the symptoms, the case is more probably one of tuberculous osteomyelitis.

Radiological examination affords more conclusive evidence when the case has been neglected or overlooked because sufficient time will then have elapsed for decalcification of the bone to be perceptible and, of course, if the case is of the chronic type, the radiologist's report is invaluable. The history of the case will serve to differentiate instances of decalcification of bone due to hæmorrhagic effusions—as in a crushed foot without fracture or infection—or due to passive œdema of a limb from an injury, e.g., a gunshot wound.

These general statements are illustrated by the following cases.

CASE 1. Robina J., 12 years of age, collided with a telegraph boy wheeling a bicycle, and limped home; 7 days later she was seen at a hospital and her case was diagnosed as "rheumatism." More accurate cross examination of the mother would have revealed two important facts: (1) that the onsets of the pain and swelling were not synchronous, and (2) that the swelling when first noticed was over the end of the bone, namely, on the posterior surface of the tibia behind the internal malleolus, and was not at the time a general swelling of the whole ankle joint. On the fourteenth day after the accident the operation took place; from the usual situation on the posterior surface of the lower end of the tibia, I evacuated half an ounce of pus from a small subperiosteal abscess and from the center of the bone. To the casual observer the radiogram (Fig. 10) was negative, even at the end of 14 days, but the slight hiatus in the outline of the compact bone (Fig. 10a) corresponds exactly in position to the opening through which the central abscess burst beneath the periosteum. This girl, in spite of the delayed treatment, made an excellent recovery and a year later Dr. R. E. Roberts reported that without the history, he would not have known from the roentgenogram that the tibia had ever been diseased.

CASE 2. Dorothy J., aged 13 years, had no history of trauma but had suffered for 4 days from

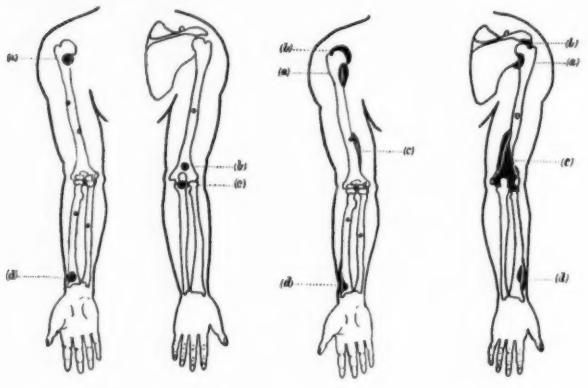


Fig. 1. Maximal points of tenderness in early cases of osteomyelitis. Anterior aspect of upper extremity.

Fig. 2. Maximal points of tenderness in early cases of osteomyelitis. Posterior aspect of upper extremity.

Fig. 3. Sites of subperiosteal abscesses from osteomyelitis. Anterior aspect of upper extremity.

Fig. 4. Sites of subperiosteal abscesses from osteomyelitis. Posterior aspect of upper extremity.

acute pain and tenderness in the lower end of the femur. Her temperature on admission was 103 degrees F. "One-finger" tenderness was present just above the epiphyseal line in the popliteal space. Figure 11 shows the roentgenogram, which is negative. Operation disclosed a normal periosteum but 1 fluid dram of pus within the bone. Complete healing resulted in 6 weeks.

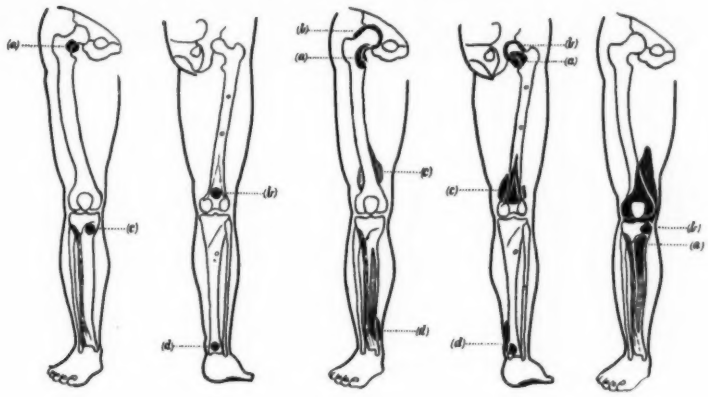
It is unnecessary to quote or illustrate further cases in order to prove and emphasize the necessity for operative measures advocated solely upon the clinical evidence even when the radiological picture discloses nothing abnormal.

POSITION AND EXTENSION OF THE SUBPERIOSTEAL ABSCESSES

Let us now consider an average case in which some swelling is present. This swelling may be due merely to œdema of the periosteum but much more commonly actual pus is found to be present at the time of the operation. It must be emphasized again that osteomyelitis commences in the bone, and therefore the term "periostitis" conveys a false pathological impression of the disease. The central abscess in the bone probably finds its way to the surface of the bone through the vascular foramina, and upon the number of these depends the situation of tenderness and subsequent swelling. The sites of the swellings which appear about 48 hours after the onset of acute infective osteomyelitis and their method of extension in the upper extremity are illustrated by Figures 3 and 4.

The subperiosteal abscess at the upper end of the humerus spreads equally in an anterior and posterior direction (Figs. 3a and 4a) around the inner side of the humerus and therefore lifts the important vessels inward away from the bone. Early operation upon such a case will show in many instances that the inflammation has not extended into the joint. But, unfortunately, the capsule of the joint extends downward to be inserted into the periosteum of the humerus, and therefore joint involvement at this situation does occur early and commonly (Figs. 3b and 4b). General œdema of the arm resulting from an acute infection at the upper end of the humerus is often maximal over the lower portion of the arm; if this fact is recollected, surgical exploration at the wrong end of the bone will be avoided.

At the lower end of the humerus, the subperiosteal abscess usually spreads upwards and laterally (Fig. 4c), more to the inner than



5 6 7 8 9

Fig. 5. Maximal points of tenderness in early cases of osteomyelitis. Anterior aspect of lower extremity.
Fig. 6. Maximal points of tenderness in early cases of osteomyelitis. Posterior aspect of lower extremity.
Fig. 7. Sites of subperiosteal abscesses from osteomyelitis. Anterior aspect of lower extremity.
Fig. 8. Sites of subperiosteal abscesses from osteomyelitis. Posterior aspect of lower extremity.
Fig. 9. Sites of subperiosteal abscesses from focus at the upper end of the tibia.

to the outer side, and gradually extends anteriorly (Fig. 3c). Involvement of the elbow joint by direct extension is common, because, unfortunately, the bone in this region is very thin and because a tongue of diaphysis extends downwards to take part in the formation of the trochlear surface which separates the center of ossification of the internal condyle from the rest of the epiphysis.

The subperiosteal abscess from the upper end of the ulna points backward and must be distinguished from olecranon bursitis, a mild degree of which is also a natural concomitant of osteomyelitis in this position. Joint involvement is rare, except in neglected cases.

At the lower end of the radius, the subperiosteal abscess (Figs. 3d and 4d) extends upwards and outwards beneath the extensor tendons of the thumb and may point on either side of these. Tenosynovitis of these muscles is usually present but this must not divert the attention from the recognition of the causal lesion in the bone.

The situations and modes of extension of the subperiosteal abscesses in the lower limb are illustrated by Figures 7, 8 and 9.

From the neck of the femur a small abscess (Figs. 7a and 8a) collects round the neck and at an early period, although not invariably, it will burst into the hip joint (Figs. 7b and 8b). This common and disastrous sequel is surely one which may more often be prevented.

When the central abscess at the lower end of the femur emerges it lifts the loose periosteum between the supracondylar ridges and then extends upward and laterally chiefly on the inner side (Fig. 8c) and thus gains the anterior surface of the femur (Fig. 7c). Involvement of the knee joint is uncommon because of the relations of the capsule posteriorly and the presence of a subsynovial pad of fat which protects the synovial membrane anteriorly in advanced cases, but in fulminating cases, extension into the joint may occur together with separation of the epiphysis.

From the upper end of the tibia, a central infection will spread downward along the subcutaneous anterior surface of the bone (Fig. 9a) but, because of the close proximity of the capsule of the knee joint to the septic focus, joint involvement is a very common although avoidable complication (Fig. 9b).

From the lower end of the tibia, the abscess spreads inward and upward on to the anterior subcutaneous surface (Fig. 8d and 7d). Marked œdema around the malleoli is a prominent feature; this, in early cases, is an effect of gravity, and exploration will not reveal any pus at this stage—indeed, incisions below the malleoli are indicative of erroneous location; they are necessary only to open subcutaneous abscesses in neglected cases. The ankle joint usually develops a serous synovitis, but suppurative arthritis there is extremely uncommon. Acute osteomyelitis of the fibula is easily recognized and localized because the bone is subcutaneous.

The acute subperiosteal abscess bears no relation in size to the central abscess; indeed, Nature may have forestalled the surgeon so far as to leave the patient with a healing central lesion although an extensive subperiosteal abscess is present. In such cases, no pus under tension will be found on drilling the bone; in fact, if the patient's temperature is low and the aperture connecting the subperiosteal abscess with the central cavity is large, drilling may be unnecessary, just as a tooth need not always be removed when an abscess is pointing in the neck or on the face. Before leaving the subject of the subperiosteal abscess it may not be out of place to point out that bare bone is not necessarily dead bone and that extensive sequestra, involving for example one-third of the bone, are rare; these can be produced only through failure of the periosteum to burst subcutaneously so that a tension is created high enough to induce thrombosis of the nutrient arteries, or through injudicious and rough investigation of the abscess cavity at the time of the operation leading to rupture of these vessels. Obviously the nutrient vessels to bone are of great importance and all operators should consequently be familiar with their situations.

POSITION AND EXTENSION OF SUBCUTANEOUS AND INTRAMUSCULAR ABSCESSES

The subcutaneous and intramuscular abscesses and their subsequent sinuses result in late cases from the bursting of the subperiosteal abscess. They may point at either border of a covering muscle or may be directed away from the primary lesion by the ease of spread along vessels or by the influence of gravity. The positions at which they are commonly found will now be indicated.

Upper extremity. The subcutaneous abscess from osteomyelitis at the upper end of the humerus points on either side, but more often at the anterior side, of the deltoid muscle near its insertion; this is in contrast to disease of the clavicle which leaves sinuses near the origin of this muscle. The abscess from the lower end of the humerus points usually just above the internal condyle; less commonly it may appear above the external condyle; that, derived from the upper end of the ulna, reaches the surface either directly over the olecranon or, under the influence of gravity, lower down on the posterior surface of the forearm; and the abscess from the lower end of the radius may point on either side of the extensor tendons of the thumb.

Lower extremity. An abscess derived from the upper end of the femur may point in three different positions: (1) on either side of the adductor longus tendon with extension, from gravitation as in psoas abscess, down the inner side of the thigh, (2) on either side of the sartorius, and (3) at the lower border of the gluteus maximus, toward which it has been directed by the internal circumflex artery and by gravity when the patient has been confined to bed. From the lower end of the femur, the abscess points usually on the inner side of the thigh and much higher than may be expected, if the patient be in bed with the knee flexed, which posture induces the pus to burrow among the posterior muscles. Occasionally in ambulatory cases, the pus may descend through the popliteal space deep to the calf muscles and reach even to the tendo achillis. An abscess arising from the upper end of the tibia is visible directly over the anterior surface of the bone, but, if the knee joint is involved, the exit is variously situated around the anterior aspect of the joint, more commonly toward the inner side of the thigh. The abscess from the lower end of the tibia either points directly over the subperiosteal abscess on the anterior

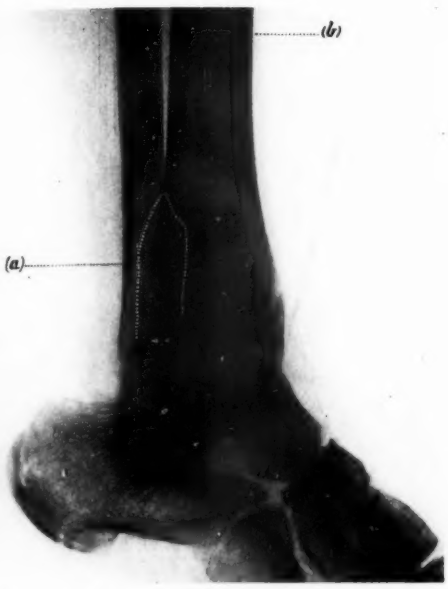


Fig. 10. Early osteomyelitis of the lower end of the tibia, in Case 1. Note the break in the compact bony outline at *a* through which tension was relieved by Nature. The extent of the subperiosteal abscess is indicated by the dotted outline. At *b* there was œdema of the leg but no pus. The extended posture of the ankle is to be observed; a preliminary aspiration of the joint revealed a yellow-tinged synovial fluid. Ankle movements, commenced the following day, were painless and no stiffness resulted.

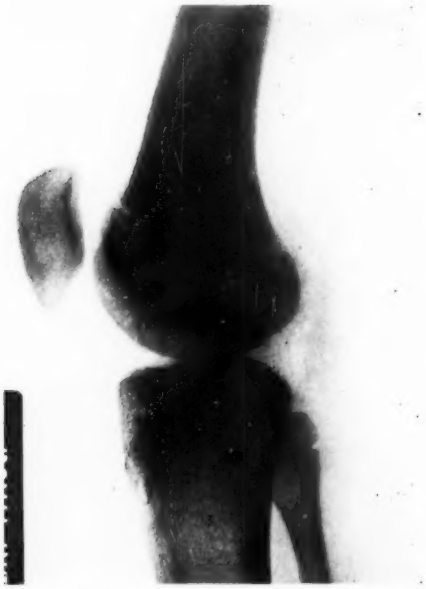


Fig. 11. Early osteomyelitis of the lower end of the femur in Case 2. Radiological evidence was negative.

surface of the tibia or, influenced by gravity, often travels deep to the internal annular ligament and points on the inner aspect of the foot.

SITES OF MAXIMAL DISEASE AS ILLUSTRATED BY MUSEUM SPECIMENS

The pathological changes resulting from chronic infective osteomyelitis of acute origin are apparent in the photographs taken from specimens kindly lent by Prof. E. E. Glynn. In Figure 12, there is a large cloaca posteriorly in the metaphysis of the lower end of the femur, but the joint cartilage is comparatively healthy. Figure 13 exhibits in the posterior aspect of the bone an involucrum or bridge of new bone formed from the raised periosteum; in this case the epiphysis and joint are healthy. In Figure 14, there is a large sequestrum on the posterior surface of the femur; the rest of the bone is healthy but it is so definitely thickened that, in pre-radiological days, the leg was amputated on the assumption that the condition was sarcomatous (Brodie's abscess): the joint is healthy.

These specimens may serve to confirm the statements that the septic focus originates in the metaphysis, that at the lower end of the femur it is the posterior surface which is almost invariably affected, and that involvement of the joint need not necessarily follow even in neglected cases.

Three photographs are reproduced of chronic osteomyelitis of the upper end of the tibia; they are all probably of tuberculous origin. In Figures 16 and 17 the lesions are diaphyseal and the joints are healthy; the "carious" sequestrum in the latter figure is apparent. Figure 18 depicts a "cold abscess" in bone with a "pyogenic" membrane situated in the diaphysis and extending posteriorly and subperiosteally into the knee joint. These figures demonstrate that the initial focus of osteomyelitis at the upper end of the tibia is on the anterior surface of the bone

12 13 14 15

Fig. 12. Osteomyelitis of the lower metaphysis of the femur showing large posterior cloaca.

Fig. 13. Osteomyelitis of the lower end of the femur, showing posterior bridge of bone formed by raised periosteum.

Fig. 14. Osteomyelitis of the lower end of the femur, showing thickening of bone and posteriorly a large sequestrum.

Fig. 15. Result of partial diaphysectomy of the tibia for osteomyelitis.

and is diaphyseal in origin. The significance of these specimens in the elucidation of the starting points of tuberculous osteomyelitis and arthritis will be discussed later.

TREATMENT OF ACUTE INFECTIVE OSTEOMYELITIS

Most surgeons will limit their technique to drilling the bone in the earliest stage and will gouge only when a well-formed central abscess is present. Within the first 3 weeks, subperiosteal resection should never be performed. Cases are exhibited from time to time of reconstructive operations to replace a portion or the whole of the shaft; their success depends on performance at a late period of the infection, when radiological evidence can be obtained that new bone is being laid down by the periosteum. Partial diaphysectomy is not an operation to be lightly undertaken in cases received at the onset of the disease. The final result in a patient who survived this operation is illustrated in Figure 15; the deranged axes of the knee and ankle joints should be noted and the ligamentous tissue which once joined the ends of the bone.

In approaching the lesion in the bone, it is advantageous to modify the incision so that the surface of the bone may be drilled or gouged in the most desirable position; surely it is bad surgery to drill the anterior surface of the lower end of the tibia or femur, or the posterior surface of the radius, and every endeavor should be made to establish drill holes on those surfaces where, as has already been described, the central abscess most commonly reaches the surface. Again, when opening the subperiosteal abscess, due regard must be paid to the nutrient artery, since, if this be damaged, one-third or one-half of the bone may be lost. Damage to the nutrient

16 17 18

Fig. 16. Chronic osteomyelitis (tuberculous?) in diaphyseal portion of the upper end of the tibia.

Fig. 17. Chronic osteomyelitis (tuberculous?) in diaphyseal portion of the upper end of the tibia, showing "carious" sequestrum.

Fig. 18. Cold abscess (tuberculous?) with "pyogenic" membrane in the diaphyseal portion of the tibia; the infection traveled posteriorly and subperitoneally into the knee joint.

vessel is usually the result of late surgery, but occasionally it may be due to bad surgery, just as osteomyelitis of the patella can be produced by a careless operator through the nicking of the patella when a suppurating pre-patellar bursa is being opened or excised.

Free drainage is the keynote of success and frequent probing of the sinus must be avoided. All secondary operations for the removal of sequestra should be well-spaced in regard to time, and we should remember that normally it takes about 6 weeks for a sequestrum to separate. X-ray examinations are of extreme value but less so than the intermittent bursts of pus as an indication of the presence of dead bone, which even in large bulk is occasionally indetectable in a roentgenogram.

JOINT INVOLVEMENT FOLLOWING OSTEOMYELITIS

If the early diagnostic signs are regarded and if the operation is undertaken without delay, this complication should occur much less frequently than it does. It arises, of course, most commonly in those joints in which the capsule extends on to the metaphysis. The knee from the upper end of the tibia, the hip from the femur, the shoulder from the humerus, and the elbow from the humerus, are all very commonly—or almost constantly—involved and this need not be the case provided early treatment is accomplished. The involvement of the joint is far too often the result of a rupture into the joint of the subperiosteal collection of pus which could easily have been evacuated from below and extra-articularly if the condition had been recognized in time.

TUBERCULOUS OSTEOMYELITIS AND ARTHRITIS

The method of joint involvement just stated affords an explanation of why those in charge of surgical tuberculosis not infrequently obtain entirely successful results in cases diagnosed as tuberculous arthritis. Thus, the perfect joint movements which follow treatment, e.g., of a hip exhibiting muscular spasm and cold abscess formation, force one to the conclusion that the primary tuberculous focus on spreading to the periosteum has failed to extend into the joint and that the case has remained throughout one of osteitis and not of arthritis.

A series of roentgenograms, which Dr. T. H. Martin, medical officer in charge of the Leasowe Cottage Hospital for Surgical Tuber-

culosis has kindly lent me, contradicts the assumption and illustration of Calot[1] that tuberculosis commences beneath the articular cartilage. The initial lesion lies about the epiphyseal cartilage as frequently on the diaphyseal side as in acute infective osteomyelitis. This opinion has also been formed from my small clinical experience of adult cases and it is supported by pathological evidence (Figs. 16, 17, 18).

A word of warning is again necessary upon the insignificance of negative radiological reports, especially in adults; although, in contrast to acute infective osteomyelitis, definite radiological evidence is present in the more acute forms of tuberculosis within 48 hours of the onset of pain, etc., cases frequently occur where a "cold abscess" of large size precedes by months definite radiological evidence in the spine, hip, etc. So frequently are early cases of tuberculosis diagnosed as hysterical, and discredit thereby brought upon our profession, that one would urge practitioners to reserve their diagnosis of obscure joint complaints until 4 roentgenograms taken at 3 monthly intervals have failed to reveal a focus—unless, of course, "cold abscess" formation removes the doubt—and to treat such cases provisionally as tuberculosis, paying particular attention to the toxæmia by which they are usually accompanied.

It should be noted in this connection that the occurrence of an evanescent swelling over the end of a bone often indicates deep-seated tuberculosis. Osteitis is not always in the directions indicated for acute infective osteomyelitis, thus, for example, from a focus at the lower end of the tibia, the abscess may point forward.

Because of the segregation of surgical tuberculosis, general surgeons have fewer opportunities for studying such cases but they cannot fail to appreciate the good results obtained by conservative, rather than operative, measures.

If, however, radiologically more diaphyseal lesions are being demonstrated than the textbooks would suggest—there is surely an indication that from time to time those accustomed to bone surgery will be tempted to explore this early lesion on those rare occasions when it is encountered, rather than let nature take its course. When the latter method is followed joint involvement may ensue—a course which reminds one of the days of perityphlitis when the appendicular focus was unrecognized.

[1] Calot. Indispensable Orthopædics, London.

SUMMARY

1. The foci of acute osteomyelitis are in the diaphyses of long bones; their positions and lines of extension to the periosteum are almost invariable and are indicated for each long bone.

2. Maximal tenderness on deep pressure over the osseous focus is present and is of diagnostic importance in early stages prior to the development of the subperiosteal abscess, which usually forms on the diaphyses near the epiphyseal line.

3. Roentgenograms in early cases may be valueless and misleading; only those which are taken tangentially to the position at which the subperiosteal abscess usually forms, are likely to show evidence of early disease.

4. Surgical procedures by the routes indicated should be directed to the points of maximal tenderness without delay in order to obviate extensions to the joints.

5. Tuberculous infections appear to originate in osseous foci and to extend similarly; for extremely early cases, operative measures at the hands of experts appear logical.

My thanks are due to Prof. R. E. Kelly for clinical material so kindly placed at my disposal and Prof. Walter J. Dilling for valuable assistance with the illustrations, etc.

THE SURGICAL IMPORTANCE OF X-RAY EXAMINATION OF THE TRACHEA AND THE BRONCHI

By PROFESSOR A. EISELSBERG, Vienna, Austria
Director of the I Surgical University Clinic
AND
DOCENT M. SGALITZER, Vienna, Austria
Chief of the X-Ray Laboratory of the I Surgical University Clinic

IT is well known that the trachea is easy to examine by means of roentgen rays, and the reason for this is that it is a hollow cylinder filled with air which is embedded in organs of greater density. The result is that the wind-pipe absorbs much less of the rays than the vicinity, thus making its differentiation easier. But we must not only be able to create an X-ray picture of the trachea; we must also recognize changes in its form and position. As long as we had examined the trachea only with a sagittal direction of the rays, our knowledge of such changes remained circumscribed; for a plate or a fluoroscopic examination under sagittal irradiation can reveal only lateral displacements or corresponding compression of the wind-pipe, but will never disclose a dorsoventral displacement or a corresponding narrowing of the tracheal lumen. A picture of the latter changes can be seucred only through lateral irradiation of the trachea (7).

The patient lies on one side at an angle of 90 degrees to the table (Figs. 1, 2, 3). The shoulders are bent maximally backward, the arms are pulled backward, and the hands are clasped. In this position, with the humeral epiphyses directly over each other, the patient is fixated with the girdle of the Bucky-Potter diaphragm, the knees drawn up (this makes the position more stable). The patient's head is fixated at a natural height by means of sandbags and one should see that it is neither extremely stretched or bent forward. The plate should be about 18 by 24 centimeters or 24 by 30 centimeters (large format). The long side of the plate should lie parallel to the long axis of the patient's body. The central ray should fall upon the mid-point of the clavicle farthest from the plate, the projection of the ray finally falling on the center of the plate. Lilienfeld's technique for lateral photography of sternum is similar.

Figure 4 demonstrates a normal trachea in lateral projection. In contrast with plate taken with patient in anteroposterior position which would show the thoracic portion of the wind-pipe very unclearly at the best, we see the whole trachea with the cervical and thoracic sections as far down as the bifurcation. The lateral picture is, *per se*, better than the dorsoventral picture because it does away with the disturbing vertebral shadows, thus making the picture clearer, and also because it is possible to reveal the whole length of the wind-pipe. The picture in lateral projection makes it easy to recognize any changes or displacements of the trachea in a dorso-anterior direction or any flattening of the tube in the same direction.

Fig. 1.

Fig. 2.

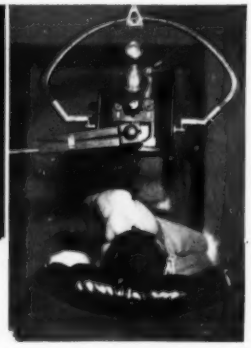


Fig. 3.

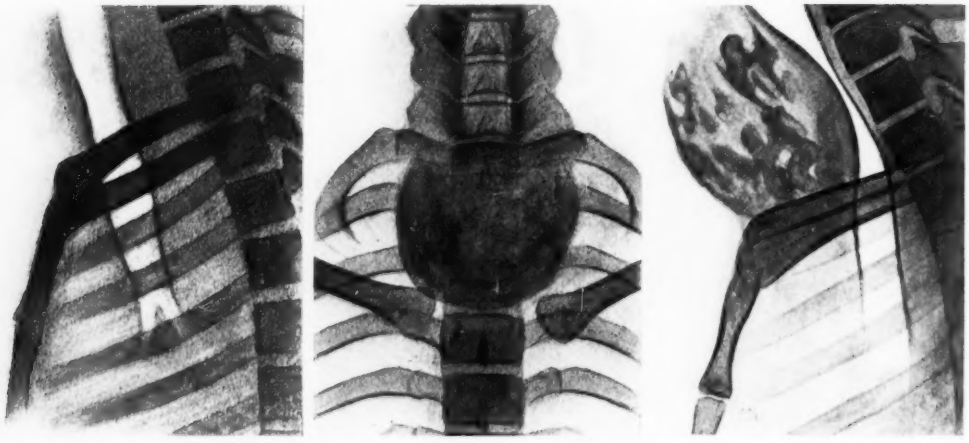


Fig. 4 left. Normal trachea in lateral projection.
Fig. 5. Marked compression of the trachea from the front by a calcified struma. The anteroposterior projection is on the left; the lateral projection is on the right.

If we add the sagittal examination of the trachea to the method of lateral projection, we achieve even greater orientation as to changes in form and position. In addition to the X-ray picture, which is of great importance, fluoroscopy is also of especial value in the examination of the trachea, because it permits us not only to examine the wind-pipe in the two chief meridians of space, but it also permits us, in turning the patient about, to examine the treachea in an infinite number of meridians, although not as clearly as with a picture. This combined method not infrequently affords us complementary material as to the character of the tracheal compression. Granted that there is good light, a wind-pipe with a regularly wide lumen will appear equally wide all along its course at every position of the patient, and its contours will be very definite, since the tracheal diameter (and thus, also, the thickness of the column of air in the trachea which is cut by the central ray) must be the same in every projected direction because of the practically cylindrical shape of the tube. Fluoroscopic examination of a trachea, the lumen of which varies at different points as due, for example, to goiter compression, is quite different. If we suppose that the pressure of the goiter occurs on the left and right sides, and reduces the size of the lumen equally from all sides to about half the size, then the thickness of the column of air which is cut by the central ray will be different in different positions of the patient. The narrowed portions of the wind-pipe will become sharper in the fluoroscopic picture in that ray meridian in which the central ray passes the greatest diameter of the trachea, that is, in the case mentioned, in a sagittal direction, and in compressions in an oblique direction, when the patient is placed in a suitably oblique position. It is inherent in the nature of the X-ray examination that it should permit of an easier and more accurate determination of displacements and compressions of the trachea than laryngological methods, whereas other questions, pertaining for example to the condition of the mucous membranes, innervating disturbances, etc. are solved only by the latter method.

Changes in the form and position of the trachea are most frequent in cases of goiter. It is in these cases that an objective determination of the condition of the trachea is of the utmost importance, since, as is well known, dyspnœa in a goiter patient is not necessarily caused by tracheal compression, but may be due to disease of other organs, most frequently that of the heart or the lungs (we must emphasize the close connections between goiter and the heart). The operative removal of the goiter in a patient in whom the dyspnœa has falsely been considered as due to a compression of the wind-pipe by the struma, would do the patient no good, but would expose him to no little danger because of the reduced resistance of the heart or the lungs. We must also bear in mind the frequent and surprising incongruence between the extent of the tracheal stenosis and the degree of dyspnœa. Thus, patients whose goiters grow slowly will be able to accustom themselves to the gradual and regular

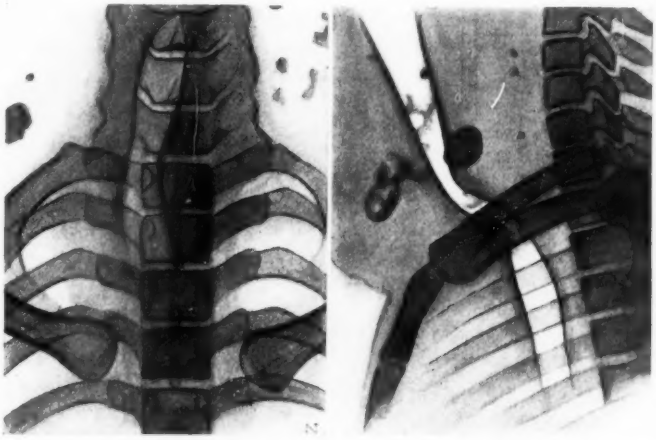


Fig. 6. Retrotracheal, calcified struma. The anteroposterior projection is on the left; the lateral projection is on the right.

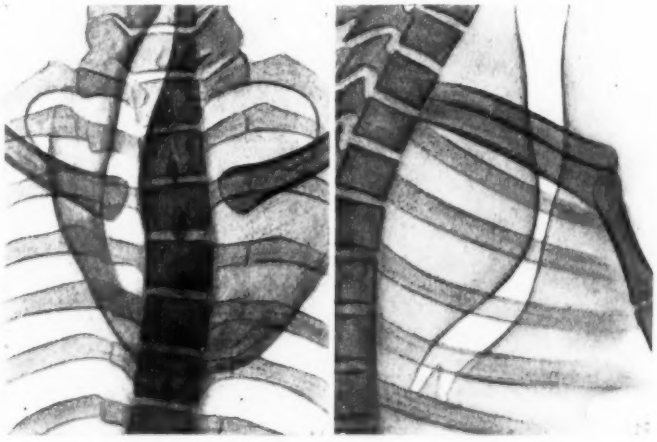


Fig. 7. Retrosternal struma. The anteroposterior projection is on the left; the lateral projection is on the right.

compression of the trachea, and will hardly become conscious of any disturbance. It is true that such patients are always in danger, since even a moderate swelling of the mucous membrane as a result of a tracheal catarrh may lead to most severe dyspnœa and suffocation. It is, therefore, necessary that an X-ray examination of the trachea of goiter patients be done even though the patient does not complain of dyspnœa. It is not at all necessary that the extent of the changes in form or position be commensurate with the size of the goiter, and these changes are often small in large tumors and can be found quite great in small ones. Accurate knowledge of the condition of the trachea is a prerequisite for operation of the thyroid. The surgeon must be well oriented on the changes in form or position of the trachea before he operates; he must know especially from which side the pressure of the thyroid tumor acts upon the wind-pipe, and to what degree this pressure has stenosed the trachea; often a large thyroid lobe causes little or no symptoms of compression, while a small node may provoke the severest symptoms of stenosis.

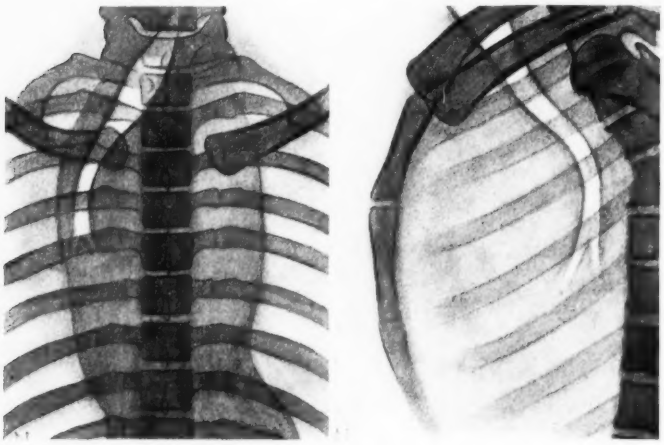


Fig. 8. Transposition of the trachea in a case of aneurism of the aortic arch. The anteroposterior projection is on the left; the lateral projection is on the right. There is an erosion of the anterior surface of the body of the fourth and fifth dorsal vertebræ in the lateral projection.

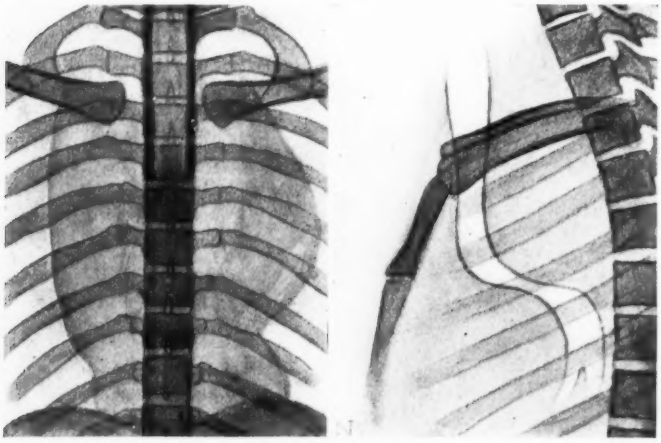


Fig. 9. Mediastinal tumor. The lateral projection (on the right) shows a severe transposition and change of form in the trachea, neither of which is shown in the anteroposterior projection at the left.

The possibilities of X-ray examination of the trachea are not exhausted by the determination of changes in form and position; with this method, rather than with any other, one is also better able to determine whether or not there is a *retrosternal struma* present. Precisely such knowledge regarding intrathoracic goiter—whether the latter be, as usual, simply a continuation of the goiter of the neck or whether the tumor is an isolated one in the breast cavity—seems to us to be of great importance; for a moderate swelling of an intrathoracic section of a goiter as a result of inflammation or hæmorrhage may cause dangerous pressure on the trachea, especially as the rigid walls of the latter preclude the equal distribution of such pressure in other directions. If ignorant of the presence of such a condition we may remove the tumor, but the cause of the stenosis, the retrosternal struma, is left. In the determination of the presence of a retrosternal

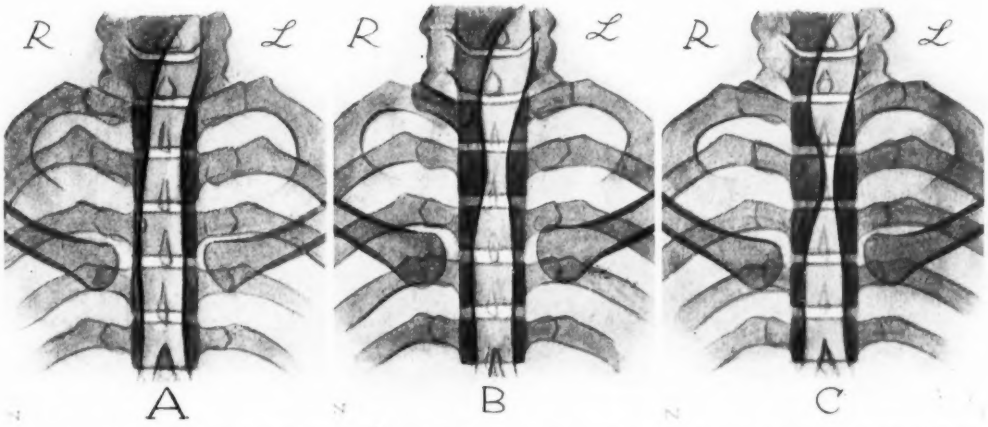


Fig. 10. Tracheomalacia of the right tracheal wall. A. Valsalva's test (increase in intratracheal pressure). There is a considerable increase in the width of the tracheal stenosis especially due to a protrusion of the right wall. B. Anteroposterior projection of a trachea compressed to the form of a saber sheath by pressure on the right and left from a goiter (normal intratracheal pressure). C. Mueller's test (decrease in intratracheal pressure). Considerable narrowing of the trachea especially due to the further depression of the right wall.

struma, fluoroscopy plays a great rôle, simultaneously affording us important information on the condition of the heart and lungs. In addition to the size and position of the tumor, X-ray examination permits us to gain information on the degree of its displacement when the patient coughs and swallows. Since the goiter is attached to the wind-pipe, it must be lifted on coughing or swallowing, unless it is more solidly attached to the neighboring structures. The X-ray determination of whether or not the goiter is sufficiently lifted under these circumstances is one of the important criteria for the kind of treatment (operative or conservative). If the displacement

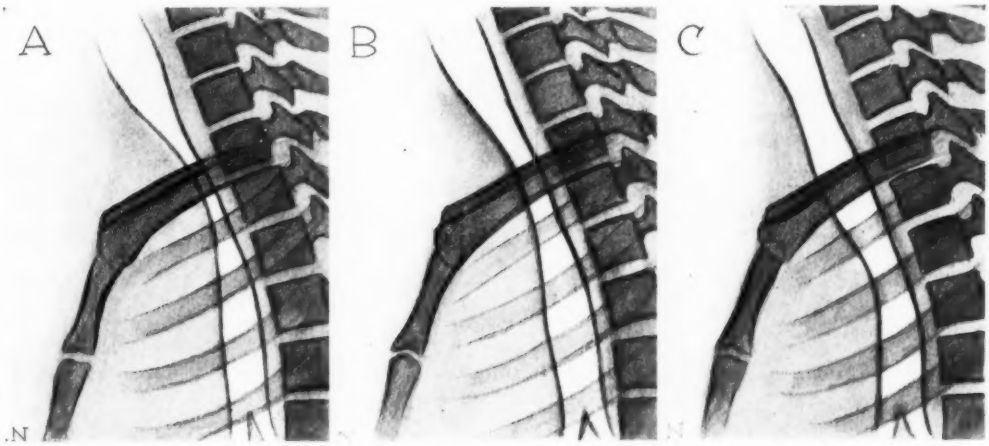


Fig. 11. Malacia in the region of the anterior tracheal wall. A. Mueller's test (reduction of intratracheal pressure). Considerable narrowing of the trachea as a result of the further depression of the anterior tracheal wall. B. Lateral projection of a trachea compressed from the front by a goiter (normal intratracheal pressure. C. Valsalva's test (increase in intratracheal pressure). Considerable widening of the trachea due to distention of the anterior tracheal wall.

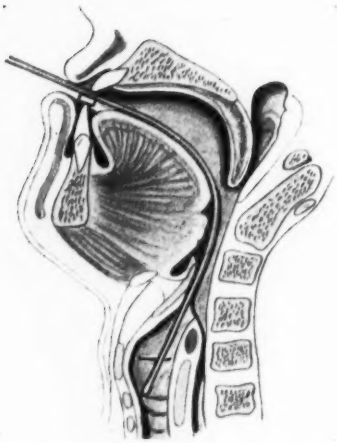


Fig. 12. Position of the laryngeal catheter. One end lies under the glottis and the other is fixated between the teeth by means of a biting cap.

is but moderate, then we must consider that adhesions are present which would make operation difficult. An attempt to dislodge an intrathoracic goiter, which has been fastened to the neighboring organs, may easily lead to the rupture of thin veins and thus also to air embolus or asphyxia. The length of operation can enhance the incidence of a mediastinal emphysema, provoke injuries to the pleural apex, damage to the nervus recurrens, etc.

We present some pictures which illustrate the value of X-ray examination of the trachea from both the sagittal and lateral aspects. Figure 5 shows, in the anteroposterior picture on the left, a dense shadow in front of the wind-pipe. This is seen to be a calcified struma in the lateral view

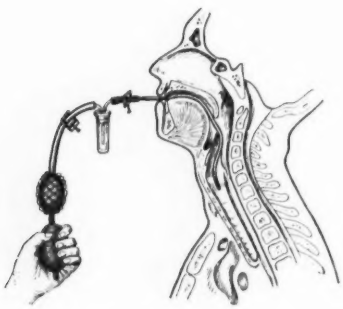


Fig. 13. Showing the laryngeal catheter in place and the apparatus for filling the bronchial tree.

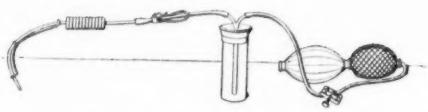


Fig. 14. The apparatus for filling the bronchial tree (H. Reiner, Vienna IX).

shown on the right. But there is still another reason why the trachea was hardly visible in the anteroposterior view. The trachea has been so flattened in the sagittal direction that the X-rays pass through a very narrow layer of air in the tube, thus creating a hardly visible picture. Figure 6 illustrates the changes which affect the trachea as a result of a calcified, retrotracheal struma. As is shown in the lateral view on the right, the trachea has been pushed forward and compressed from behind. In the anteroposterior picture on the left, the trachea is hardly recognizable because of the frontal flattening. A marked compression of the wind-pipe as a result of the action of a retrosternal goiter is illustrated in Figure 7.

Displacement and compression of the trachea are found not only in cases of goiter or glandular tumors of the neck, but, as the examination of the trachea in pictures of two perpendicular projections will show, such changes are also found in intramediastinal diseases, especially mediastinal tumors and aneurisms of mediastinal vessels, but also not infrequently in divers diseases of the lungs (contractive processes, tumors, etc.) and the pleura (effusions, accumulation of air, and tumors). The condition of the trachea can, among other symptoms, often be a differentially diagnostic factor between aortic aneurism and mediastinal tumor (6). Whereas an aneurism, especially one of the aortic arch, will displace the trachea in a lateral direction, such a change of position with the presence of a mediastinal tumor takes place in a dorsoventral direction (with the exception of intrathoracic goiter). A marked compression of the trachea, as is so often found in X-ray examination of mediastinal tumors, is seldom found in cases of aneurism. The type of tracheal displacement further affords us a means of diagnosing the source of the aneurism (ascending or descending aorta, the arch). Corresponding to the topographic relationships, aneurisms of the ascending aorta will displace the trachea frequently toward the left and backward, whereas aneurisms of the arch, corresponding to their proximity to the left wall of the trachea, will displace the latter toward the right. Aneurisms of the descending branch, finally, will push the

trachea toward the front or the right, if they are still within the region of the trachea altogether. The most intimate relationships with the trachea are to be found in cases of aneurism of the arch.

If, in the case of an unilaterally contracting pulmonary tuberculosis, the trachea is not only pulled to one side, but also advanced toward the anterior or posterior wall of the thorax, the clinical methods of examining by percussion and auscultation may lead to the mistaken diagnosis of cavities. The marked transposition suffered by the trachea in cases of aneurism of the arch are illustrated by Figure 8. Figure 9 shows a twofold bend in the trachea in the lateral view on the right. This picture is from a case of mediastinal tumor, and the anteroposterior picture on the left gives no idea of the severe changes which the trachea has suffered. These are to be seen only in the lateral view on the right.

X-ray examination of the changes in form and position affecting the trachea, the diagnosis of an intrathoracic goiter, the determination of the condition of the heart, lungs, and œsophagus do not entirely complete the possibilities of this method. We are also able, by means of X-ray examination, to form an opinion on the *resistance of the tracheal cartilage*, an important consideration in determining further procedure. It is precisely this knowledge which should not be underestimated in considering the amount of danger to the patient which results from the pressure of the goiter on the wind-pipe. The solidity of the cartilage may be reduced by the pressure of an old goiter; the cartilaginous support may disappear in part, and the ominous picture of *tracheomalacia* may appear and threaten the life of the patient. With X-ray examination this condition can be recognized, and is an absolute indication for operation, even though the cartilaginous structure of the trachea is, itself, not visible. Such a weakening of the cartilaginous support of the wind-pipe may be deduced from the way in which the lumen of the trachea is widened or narrowed by increase or decrease in intrathoracic pressure (8). It will not be difficult to conclude that malacial changes of the cartilage are present in the region of a tracheal stenosis if the width of the tracheal lumen increases markedly upon increase of intrathoracic pressure or if the former is definitely reduced upon reduction of the latter. The increase in pressure is provoked by Valsalva's test (expiration with the external air passages closed), a decrease by Muellers test (inspiration with the external air passages closed). These remarkable oscillations in the width of the tracheal lumen during these tests are easily explained by the reduction in resistance of the tracheal wall at the points of malacial transformation. With increase in pressure this transformation leads to an abnormal protrusion of the wall; as soon as the intratracheal pressure is reduced,

Fig. 15. The patient holds the laryngeal catheter between his teeth, ready for filling the bronchial tree while behind the X-ray apparatus.

Fig. 16. Position of the patient for filling the right lower lobe in bronchography.

Fig. 17. Position of the patient for filling the right upper lobe in bronchography.

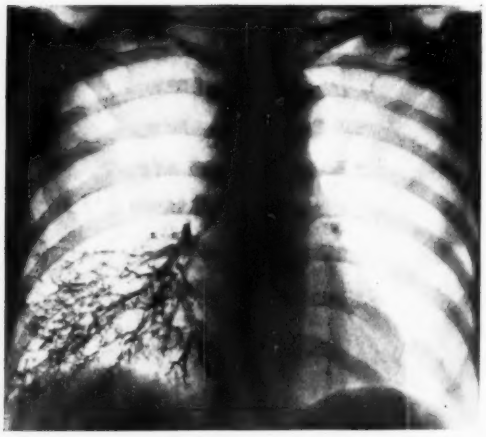


Fig. 18. Bronchography. Normal bronchial tree of the right lower lobe.

there is necessarily a marked depression at the same point. On the other hand, the changes in shape of the trachea in cases with unaffected cartilaginous rings are relatively slight; they are at least equal on both sides, concentric, whereas the malacial changes are usually abnormally marked, eccentric, because the affection usually seizes but one side of the tracheal wall. We are thus able to make a functional examination of the cartilaginous support of the tracheal wall, to test its reaction to increase and decrease of intratracheal pressure, and to gain important information on its resistance. However, it would be too much to have the examining physician explain both the Valsalva and the Mueller tests to every goiter patient during X-ray examination of the trachea. This would be especially impossible in the case of the mass material of a clinic. It is quite sufficient for practical purposes to substitute simple coughing for the Valsalva test and sniffing (Hitzenberger) for the reduction of intratracheal pressure. Before the patient carries out these measures, he must be slowly turned into the position behind the fluoroscopic plate in which the trachea is most visible, i.e., the position in which the central ray passes through the greatest diameter of the tracheal stenosis.

There is naturally a gradual transition in many cases from marked malacia to normally constituted cartilaginous rings, and the cases with varying degrees of reduced resistance are marked by correspondingly large or small excursions upon changes of pressure. In such cases, it is of especial value to make a picture in order to compare definite stages of the form of the trachea under normal and varied pressure conditions (Valsalva and Mueller tests).

An excellent case of tracheomalacia is illustrated in Figure 10. The tracheal stenosis is seen in the middle with the breathing normal, i.e., under normal air pressure (there is a saber sheath compression). The picture on the left shows the condition of the trachea when the pressure is increased (Valsalva test), and the one on the right when the air pressure is reduced (Mueller's test). There is a very great difference in the width of the lumina between the pictures A and C. The malacia primarily affects the right wall of the trachea. A second case of tracheomalacia, which was especially recognizable in the lateral view, is illustrated in Figure 11. The center picture, B, shows the lateral view of the trachea with normal breathing, i.e., normal pressure conditions. The trachea is pushed in from the front. The picture on the left shows the condition of the wind-pipe when pressure is reduced (Mueller's test), and C shows the trachea under increased air pressure (Valsalva). The changes in the size of the lumen are remarkably great; the X-ray examination suggests a diagnosis of tracheomalacia of the anterior wall of the wind-pipe (cervical section). In this case, as well as in the foregoing one and in many others, the operation corroborated the roentgenological findings.

The systematic testing of the resistance of the tracheal cartilages to changes in pressure during X-ray examination is likely to become very helpful in our choice of the type of treatment for

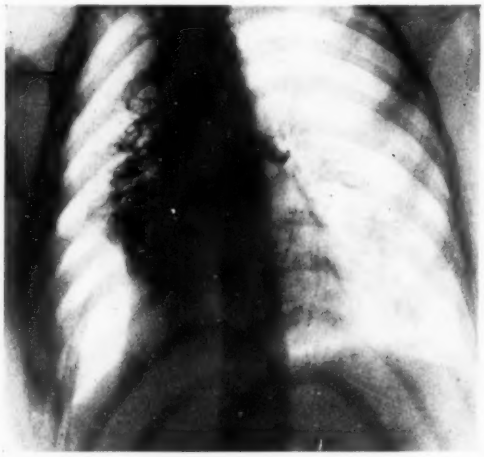


Fig. 19. Bronchography of the contracted lung in empyema. The shrunken lung reveals no foci of decomposition.

goiter patients. It need not be especially emphasized that a diagnosis of marked malacia is an absolute indication for operation. In the presence of even a slight reduction in the resistance of the cartilaginous support of the trachea operation would seem advisable unless severe diseases of the heart or lungs were present.

X-ray examination of the effect of pressure changes on the tracheal wall will doubtless be of especial value for therapeutic indications—operative or conservative treatment—in those complicated cases in which a large portion of the tumor reaches down into the mediastinum and compresses the thoracic section of the trachea, and in which the thyroid tumor is seen to be hardly movable, i.e., attached to its vicinity, upon coughing and swallowing behind the fluoroscopic plate. In such cases it is very difficult to decide upon treatment, particularly if marked cardiac lesions are present. A diagnosis of a weakening in the tracheal cartilages in the thoracic section will make it more advisable to operate despite the dangers of operation, than to treat the patient expectantly, granted, of course, that the internal findings have also been taken into consideration.

BRONCHI

In this paper we wish to consider only the method of broncoghraphy which has been developed in recent years, the method of introducing a substance, an iodized oil, iodipin (Merck), or lipiodol, into the bronchial tree, which throws a shadow and thus makes the X-ray examination of even the finest branches of the bronchi possible. The method of contrast fillings of the bronchial tree was first suggested by an American, Jackson,

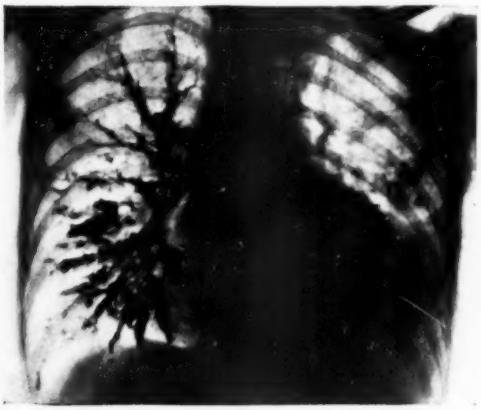


Fig. 20. Bronchography. Cylindrical bronchiectases.

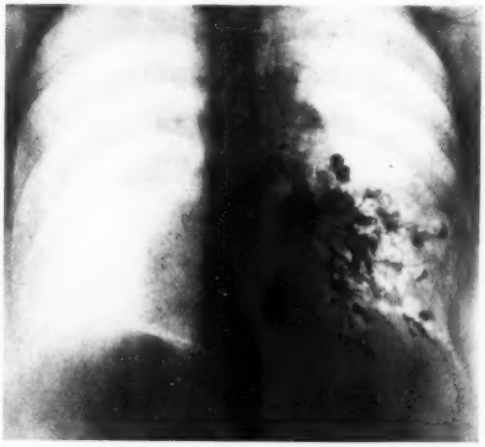


Fig. 21. Bronchography. Encysted bronchiectases.

and by Lynah. It was only a few years later, however, that the method experienced a remarkable advance through the work of Sicard, Forestier, and Leroux. These authors all mentioned different methods of introducing the contrasting iodized oil, but all these methods have the common characteristic that the X-ray examination of the lungs is carried out only *after the iodized oil has been introduced into the bronchi. The introduction of the contrast mass is thus done without the guidance of the roentgenologist.* This not infrequently leads to a lack of filling in precisely those bronchi which are of diagnostic interest. To obviate this difficulty Haslinger, who carried out such examinations with Lenk, constructed a bronchial sound which, after the larynx and the trachea have been anæsthetized, can be introduced into any desired bronchus and the contrast media injected. This method will hardly become generally used, since it demands a rather high degree of specialization and also puts a greater burden on the patient than is desirable, especially if the patient is tuberculous. Beck and Sgalitzer have developed a method at the Vienna Ear and Surgical Clinics (1 and 2) which is simple, which does not demand too much assistance on the part of the patient, and which also possesses the advantage of introducing the iodized oil directly into the bronchial tree under the control of the X-ray. The entrance of the iodized oil into the bronchial branches is observed on the fluoroscopic plate; so that this becomes analogous to the fluoroscopic examination of the stomach.

The method consists in first anæsthetizing the larynx and then introducing a soft catheter which

Fig. 22. Bronchography. Aciniform bronchiectases.

Fig. 23. Bronchography. Encysted bronchiectases.

remains in place during the entire time of the examination. Whereas the fluoroscopy could heretofore be carried out only after the contrasting oil had been introduced, this method makes it possible to observe the patient behind the X-ray plate continually from the time the oil is allowed to flow into the bronchi, and to keep the patient freely movable. The roentgenologist is completely independent of the laryngologist during the time the oil flows into the bronchi. Since, also, the patient is freely movable during the instillation of the liquid, it is possible to turn him into any position desirable for the filling of different parts of the bronchial tree.

It is not possible to observe certain parts of the lungs, for example the bronchial tree of the upper lobe or of the lower lobe, by means of a suitable transposition of the patient during this method of examination.

In all our examinations we made use of the iodized oil marketed by the firm of Merck under the name of "iodipin." It is a 40 per cent oil which gave us excellent contrast shadows and was well tolerated by the patients. We observed symptoms of iodism in only a few cases and in but a moderate degree, since the splitting off of iodine from the oil proceeds very slowly. The examination of the urine reveals the presence of but small quantities of iodine. For the prophylaxis of the patient's who perhaps swallow small quantities of the iodized oil, it is well to make a practice of administering a purgative after the introduction of the oil.

Even in cases in which we used large quantities of about 20 to 30 grams of iodipin (15 cubic centimeters are usually sufficient), we never observed any mentionable dyspnœa, and in cases treated with smaller quantities of about 15 cubic centimeters there was never any dyspnœa at all.

Sometimes there is a slight rise in temperature following the instillation of the iodized oil which lasts for about a day. The method developed by us permits us to work satisfactorily with relatively small doses of the iodized oil, since we constantly control the contrast filling with the eye.

The apparatus used by us (Figs. 12, 13, 14 and 15), consists of a semi-soft catheter with a diameter of 2 millimeters. A fine silver wire is attached to this catheter, the latter being placed under the glottis after the larynx has first been anæsthetized. The silver wire holds the supple catheter in place in the laryngeal curvature desired, and also permits of a constant control and observation of the position of the latter. The portion of the catheter in the mouth is attached to a hard rubber cup held in the teeth; so that the position of the catheter remains constant throughout the entire procedure of filling. The catheter is further connected with a small Junker apparatus by means of a rubber tube, the flow of the iodized oil being controlled by opening or closing a clamp attached to the connecting tube. The other tube of the Junker apparatus is attached to a regular double bulb which permits easy regulation of the pressure of the flow of the iodipin.

After the larynx has been anæsthetized with a 10 per cent solution of cocaine, the catheter, controlled by the laryngeal mirror, is introduced under the glottis, and the patient is told to grasp the rubber cap in his teeth. The small Junker apparatus is filled with iodipin and the patient is then ready to be fluoroscoped.

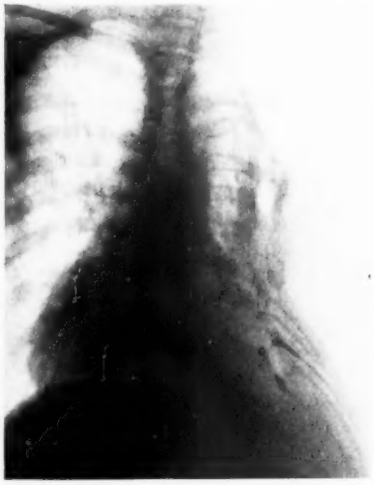


Fig. 24. Bronchography in thoracoplastic. There is a bronchial fistula here.

The patient is thus freely movable and the roentgenologist can place him in any position desirable for the filling of any portion of the bronchial tree. Pressure on the bulb forces the iodipin through the catheter into the trachea and thus into the bronchi. It is thus possible to observe where the oil flows from the very beginning. As soon as that part of the bronchial tree which is diagnostically important has been filled, the clamp on the connecting tube is closed, the instillation thus stopped, and the catheter taken out of the larynx. To prevent coughing with certainty we also always anæsthetize the trachea by means of a cocaine-adrenalin spray, in addition to the pharynx and larynx.

An even more simple technique, which was also developed at the I Surgical University Clinic in Vienna and used repeatedly there, is the method of "*swallowing the wrong way*" (Verschlucken) (3). This method is also advantageous in that it permits of simultaneous X-ray observation as in the method mentioned above. The method is based on an observation of Nather's who, in injecting contrast media in the œsophagus of a patient with an œsophageal carcinoma, simultaneously but unintentionally also injected the bronchial tree with the barium mixture. The patient, who was anæsthetized, had simply swallowed the whole mixture down the trachea (he later coughed the mixture up and had no complaints). This and other observations show that a patient whose larynx and pharynx are anæsthetized often swallows the wrong way, as is not unknown to laryngologists. What had happened unintentionally at that time was then later used by us as a method for filling the bronchial tree.

Fig. 25. Bronchiectases in one of the upper lobes.

We first have the patient clean his teeth and mouth by brushing and gargling repeatedly. Then the pharynx, hypopharynx, and laryngeal entrance are thoroughly anæsthetized with a 10 to 15 per cent cocaine solution. As soon as anæsthesia is complete, the patient is allowed to drink the contrast oil behind the fluoroscopic plate in repeated small portions. If the anæsthesia has

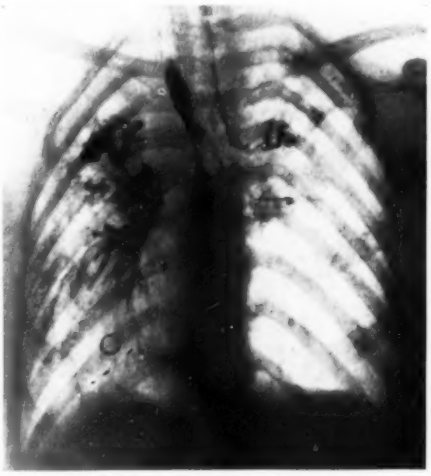


Fig. 26. Bronchography. Bronchiectases in one of the upper lobes.

Fig. 27. Bronchography. Alveolar filling.

Fig. 28. Bronchography in bronchial carcinoma. The affected bronchus has been infiltrated by the tumor and blocked. The iodized oil collects and flows over into the bronchial tree of the healthy side, although the patient was bent far over on the affected side during the introduction of the oil.

been really complete, the great majority of patients will swallow the oil down the trachea, and the flowing in of the oil as well as the direction of its course by any desirable position of the patient can be observed behind the plate.

Now and again the method of swallowing fails, especially in patients with an infantile form of the epiglottis. The method should not be used in the presence of acute or chronic infections of the buccal or pharyngeal cavities (for example, tonsillitis, sinus diseases, epipharyngitis, and ozæna). These restrictions do not, of course, hold good for the method with the laryngeal catheter; for the introduction of the catheter is independent of the form of the epiglottis, and the fluid used drops directly into the trachea, and thus avoids any infectious material contained in the naso-pharyngeal cavity. We have never observed any damages as a result of this swallowing method. We, nevertheless, now use the method with the catheter almost exclusively, since it is not only practicable in *all* cases, but also possesses the advantage that the iodized oil introduced does not come in contact with the mucous membrane of the mouth.

It is easy to see the advantages of filling the bronchial tree with contrast media under the control of the eye by means of X-ray examination. Most important of all, we are able by means of this method to measure the quantity of the oil introduced, and to interrupt the further flow of oil as soon as we have satisfactorily answered the diagnostic questions. This enables us to attain diagnostic results with relatively small doses of iodized oil. The possibility of controlling the flow of the oil into the bronchial tree also enables us to direct its course to a great extent. If, for example, large quantities of the oil collect in the wind-pipe, we can immediately interrupt the further introduction of oil until the contrast fluid has again begun to drip slowly into the bronchial tree. This precludes the possibility of many complaints on the part of the patient—dyspnœa, and coughing. It is also possible to direct the flow of the oil into certain desired parts of the bronchial tree by means of the suitable transposition of the patient.

The simplest portion of the lung to fill is the *lower lobe*. Tipping the body of the sitting patient at an angle of 30 or 45 degrees towards the desired side will lead to the proper effect (Fig. 16).

The introduction of iodized oil into the upper lobes of the lungs is more difficult. Whereas we formerly did this type of filling with the patient in side position and, perhaps, with the pelvis raised behind the X-ray wall, we later abandoned this method and began to use the X-ray table because the necessary displacements of the Crookes tube box of the irradiating wall, the work at the iris diaphragm, in short, the whole business of controlling the flow of oil into the bronchial tree under X-rays was too greatly hindered by the position of the patient on a simple examining table before the X-ray glass. We now carry out such fillings only on the X-ray table, the patient being turned on one side at an angle of about 30

degrees by means of pillows (Fig. 17). In addition to this lateral turning it will usually also be necessary to create some elevation of the pelvis by placing some flat pillows under the patient's buttocks. One should pay especial attention to the fact that the patient's head must not be the lowest point of the body. The head should be raised somewhat by means of a pillow or a roll in order to keep the entering oil from collecting in the wind-pipe and thus provoking coughing. If, with this method, the iodized fluid enters only the larger bronchi of the upper lobe in question, it will be well to increase the elevation of the pelvis as soon as the filling has been completed and simultaneously to tell the patient to breathe deeply a few times. One then observes that the contrast fluid enters the finer bronchi also and sometimes even fills the apical portions of the lung.

It will not be difficult to fill the right middle lobe if the patient is placed horizontally on the table and turned about 30 degrees on the right side.

It is, at any rate, important to keep the lungs under X-ray observation during the entire period of iodized oil treatment, since there are no absolutely binding rules for filling certain parts of the lung and since the position of the patient's body must frequently be corrected according to the momentary condition of the bronchial filling. Thus, it will often become necessary to increase the pelvic elevation in filling the upper lobe when the observer sees that the oil is not flowing entirely or in great part into that lobe; or the side position of the patient's body will have to be increased in fillings of the lower lobe, whenever the X-ray observation reveals that a part of the oil is entering the chief bronchus of the other lung.

The most important prerequisite for the introduction of iodized oil into certain, definite portions of the bronchial tree is as complete an anæsthesia as possible which precludes any coughing during the filling. Observations on patients with bronchial fistulæ, in whom the contrasting agent was introduced without the use of cocaine anæsthesia, have shown (5) that the small branches of the bronchi and the alveolar tissues tolerate the presence of bismuth without reaction. Coughing begins only when the column of bismuth has reached the hilus region, i.e., the bronchi of the first and second order. A violent coughing reaction is then provoked at the bifurcation and in the trachea. On the basis of this observation, it becomes apparent that not only the larynx and pharynx, but also the trachea should be anæsthetized by means of a cocaine spray. The degree of sensitivity varies greatly from patient to patient. Whereas some patients are completely anæsthetized by slight quantities of cocaine, and the introduction of the iodized oil then goes forward without any reaction, there are other patients in whom the choking and coughing reflexes are difficult to remove and can sometimes be stopped only after the use of an alcoholic solution of cocaine and a morphine injection. It is better to leave the lung unfilled than to do it under insufficient anæsthesia, since the desired effect will not be achieved under improper circumstances. The patient continues to be restless, will not remain in the position necessary for the filling in question, and also coughs most of the oil back out. A small quantity of the oil is pressed by the patient into the small bronchial branches and even into the alveolar tissue whenever the patient is able to keep the coughing back (this is then equal to an unintentional Valsalva test), but this usually concerns a portion of the lungs which is not at all in question. We thus lay great weight on as complete an anæsthesia of the pharynx, larynx, and the tracheal mucous membrane as possible and believe that this is the circumstance which reveals alveolar fillings so seldom nowadays.

We have never observed any harm resulting from an alveolar filling; on the contrary, we achieved an especially favorable therapeutic effect by such a filling in a patient with a very old chronic bronchitis and a very thick secretion. We nevertheless try to avoid such a filling as an undesirable co-effect. The iodipin or lipiodol which reaches the alveoles remains there and can some times be seen, hardly diminished in quantity, after several months. The resorption in the alveoles is unusually slow.

In acute, catarrhal conditions, in which a satisfactory anæsthesia is very difficult to attain, we wait with the tracheobronchial filling until the acute symptoms have subsided, regardless of the basic disease in question.

Whatever contrast oil is in the smaller and larger bronchi is usually excreted rapidly. In addition to the coughing and the action of the ciliated epithelium, the active effect of the peristalsis of the smooth musculature of the tracheobronchial wall is also of importance, as Reinberg (l. c.) was able to show. At any rate, the rapidity of the excretion of the oil depends also upon the rigidity of the thorax wall, the elasticity of the lungs, etc. Although the small and large bronchi rid themselves of their contents rapidly, there often remain roentgenologically noticeable quantities of the material in the smallest branches as a wall precipitate. Such residual material can

often be seen after 24 hours, and sometimes even after 2 or 3 days. The small residue which is normally found in bronchi with a macroscopically normal structure even a few days after introduction is always to be found in pathological conditions of the bronchi, such as bronchiectasis and decomposing foci in the lungs. Such residue remains for a more or less protracted period of time and can always be seen roentgenologically. The residual oil and also the fine precipitates which we can find only by chemical means are the sources of a possible *therapeutic effect*, especially, inasmuch as the iodized oil comes into closer contact with the walls of the bronchi after the other contents have been previously coughed up during the process of cocaine anæsthesia. As a matter of fact, we have observed a favorable therapeutic effect in a number of cases by the introduction of iodized oil into the bronchial tree in cases with small bronchiectases and bronchitis with thick secretion. In the case of large bronchiectases filled with pus in which the iodized oil cannot come into contact with the wall of the cavity, nothing is to be expected. The attempts to introduce medicaments into the bronchial tree are old, but the method developed by us for introducing such medicaments under the control of X-rays is the first attempt to exclude accidents in such medication and to apply the agent with great certainty to the point of disease. In order, however, to achieve such ends, the medicament must be of such a nature that it becomes visible under X-rays, or else the agent must be mixed with some substance which throws a shadow. Such basic substances which throw a shadow under X-rays are the 40 per cent iodipin (Merck) and lipiodol which are both, as mentioned above, combinations of iodine with the higher fatty acids. These substances are also important because of their iodine content. (We recall the important rôle of iodine medication in pulmonary tuberculosis.) As already mentioned, this close combination between the iodine and the fatty acids permits of only a very slow splitting off of iodine; so that the danger of iodism is to be considered only for patients with an iodine idiosyncrasy. These preparations also cause no unpleasant symptoms from the gastro-intestinal tract. They are both oils, substances which are especially suitable for use in the bronchial tree, and have a consistency which is very similar to that of the bronchial mucus, a circumstance which seems to us to be of especial advantage. These oils are well tolerated by the bronchial mucous membranes. On the suggestion of Pal (4) we have repeatedly introduced a mixture of equal parts of iodipin (40 per cent) and agoleum into the bronchial tree in cases of bronchiectasis and chronic bronchitis. Agoleum is a silver preparation which was introduced by Pleschner for the treatment of the bladder. The density of the shadow despite this dilution was nevertheless so good, that the 40 per cent iodipin alone hardly gave a better picture, although agoleum alone is hardly noticeable in the X-ray picture of the lung.

In respect to the quantity of iodized oil to be used for therapeutic purposes, we can say that we never use more than 10 to 20 cubic centimeters for the bronchial tree. As soon as the medicament has passed a bronchus of the second order, i.e., as soon as it has reached a pulmonary lobe, it enters the different branches of the bronchi of this lobe alternately. This is due to the fact that the distribution of the filling in any section of the bronchial tree is subject to a constant change. With every more or less forceful expiration, whenever the throat is cleared, or as a result of the action of the bronchus peristalsis, some of the iodized oil is forced from the smaller to the larger bronchi in order then to flow back into other smaller bronchi at the next inspiration. The viscous character of iodipin explains why small quantities of the oil always stick to the bronchial wall and thus have some therapeutic effect.

We make a practice of filling but one lobe or at least but one side at one sitting. We leave an interval of at least 5 or 8 days between bronchial fillings. As already mentioned there is a slight rise in temperature after the bronchial filling in some patients. In 2 cases we observed a rapid rise to over 38 degrees C. but the temperature dropped in both cases to normal within 24 hours. Such rises in temperature seem to occur especially in patients with tuberculous processes in whom we no longer carry out the filling. Usually, however, no disturbance results from the filling, and the patients often feel much better because coughing becomes so much easier.

Bronchial filling with iodine oil is not dangerous if quantities no greater than the ones mentioned are used. Aside from one transient cocaine intoxication which is not the fault of the method itself, we have never seen any damages despite a great number of cases thus handled. However, we do not consider the method to be fool proof. A filling should be carried out only if there is a possibility of a real diagnostic or therapeutic gain. It is natural that we should not only take the condition of the lungs into consideration before making a filling (we believe that an exudative form of pulmonary tuberculosis is a contra-indication to the filling), but we should also pay attention to

the general condition of the patient. Thus, for example, patients with severe cardiac or aortic changes or very nervous patients should not be treated.

Finally, we wish to present pictures which illustrate the importance of bronchography (Figs. 18 to 28).

Figure 18 shows a normal bronchial tree of the right lower lobe. Figure 19 illustrates the bronchial tree of a retracted lung in the case of an empyematous cavity. This case presented the question as to whether there was a decomposition focus in the shrunken lung. The result of the bronchography answered the question in the negative. Figure 20 illustrates immense, cylindrical bronchiectases; Figure 22, grape-like bronchiectases; Figure 23, very extensive cyst-like-ones; and Figure 21, smaller bronchiectatic sacks.

Figure 24 illustrates a thoracoplastic because of tuberculosis. Bronchography shows that there is a bronchial fistula present.

That the filling of the bronchial tree of *the upper lobe* is possible with the right technique is shown by Figures 25 and 26. In both cases, bronchiectases are noticeable in the upper lobes.

Figure 27 illustrates an alveolar filling. As we have already mentioned, such an alveolar filling is not desirable, although we have never yet seen any detrimental results. The resorption of the iodized oil from the alveoles is very slow and hardly noticeable. Such an alveolar filling is enhanced and is made liable to occur if anæsthesia of the alveoles is incomplete.

Figure 28 illustrates a bronchial carcinoma. The left bronchus is distended like an Indian club, and then follows an apparently complete block. The bronchus is manifestly substituted by the tumor. The iodized oil collects in the bronchial tree of the healthy lung, despite the fact that the patient was turned at an angle of 45 degrees toward the affected side and was finally laid on the diseased side altogether.

The introduction of iodipin into the bronchial tree is undoubtedly a great help in the radiological diagnosis of pulmonary affections. Bronchography is especially valuable in the diagnosis of bronchiectasis, because of the difficulties in clinical diagnosis and localization of this disease and in the X-ray examination without a contrasting agent. Bronchography can also be of great importance in the diagnosis of doubtful tuberculous cavities, foci of destruction in the course of gangrene, abscesses and their resultant cysts, and bronchial carcinoma. We cannot fail to mention that the possibility for studying the way in which the bronchial tree branches under normal and pathological conditions, the nature of its excretion under coughing in healthy and diseased lungs, open new vistas to research.

SUMMARY

In the X-ray examination of the trachea of goiter patients, the lateral view is also of importance in addition to the frontal one. It is only by means of the double examination in two major spatial directions that we are able to gain definite information on changes in the form and position of the wind-pipe. Fluoroscopy is also of great importance, since it enables us to see a malacia of the cartilaginous rings—a strict indication for operation because of the danger of death—in addition to affording us information as to the presence of any possible intrathoracic goiter or changes in the heart or lungs. Malacial changes in the cartilages, but also slight reduction in the resistance of these cartilages, are to be diagnosed by means of the marked dilatation of the trachea upon increase in intratracheal pressure (Valsalva's test) or an abnormal narrowing when the pressure is reduced (Mueller's test). The degree of difference in the size of the lumen depends upon the degree of malacia of the cartilages. To simplify the examination of such conditions of the wind pipe, it is sufficient simply to have the patient cough behind the fluoroscopic plate to increase pressure, or to sniff in reducing intratracheal pressure. Great difficulties in deciding whether operative or conservative therapy should be followed, especially in cases complicated by serious heart lesions, will often be removed by means of such a test of the resistance of the cartilaginous support of the trachea.

A method of introducing a contrasting oily fluid into the bronchial tree by means of a catheter for bronchography is reported. The method possesses the advantage over former methods of permitting of constant roentgenologic observation of the treatment from the very beginning. The method also prevents the iodized oil from coming in contact with the buccal mucous membranes. The patient can be brought into any desired position and the direction of the flow of oil in the bronchial tree so controlled as to fill any desired part of the lungs (including the upper lobes) at will. Only one side should be filled at *one* sitting, if possible only one lobe.

The most important factor which is necessary for successful bronchography is complete anæsthesia of the pharynx, larynx, and the tracheal mucous membrane (the latter by means of a cocaine spray). Although the method is harmless with good technique, it should be used only with a definite

indication in mind especially for the diagnosis of bronchiectases. New possibilities for the introduction of medicaments which throw shadows are also discussed.

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LARSEN–JOHANSSON'S DISEASE OF THE PATELLA

By GEORGE W. HAWLEY, M.D., F.A.C.S., and ARTHUR S. GRISWOLD, M.D., Bridgeport, Connecticut

THE precise diagnosis of lesions about the knee joint has of late reached a degree of considerable exactitude because of the increasing interest in the so-called internal derangements of the knee. Thus it was a matter of unusual interest to the authors to come upon an apparently unknown pathological entity.

CASE REPORTS

J. F., a boy 12 years of age, presented himself on April 26, 1927, with the complaint of some intermittent pain and a limp following a mild strain of the left knee sustained during a football game the previous autumn. He had not been seriously disabled but had noticed a certain amount of discomfort after exercise.

Examination of the knee showed nothing more than tenderness confined to the lower margin of the left patella. The roentgenogram showed a definite accessory center of ossification, small and somewhat irregular in outline, situated at the lower pole of each patella. Singularly, this was most clearly shown in the *right* knee, in which no symptoms were then apparent. Furthermore, on the left side, there was the well marked beak-shaped tuberosity uniformly found in cases of Osgood-Schlatter's disease (18, 21), also without symptoms. A diagnosis of "reversed Schlatter's" disease was made and the case treated as such by support with adhesive plaster and restriction of activity. In one month, tenderness had disappeared and the knee appeared normal again.

Five months later the patient returned, complaining of recurrence of pain, this time in both knees, after playing football and riding a bicycle. Examination then showed some swelling and tenderness over both patellæ at their lower borders, especially the left, and there appeared to be some actual bony enlargement at this point. Roentgenograms showed the patellæ to be pear-shaped with well marked knobs on the lower poles where fusion of the separate centers of ossification to the main bone was well advanced. It was interesting to note that while the separation between the two centers of ossification was distinct in the roentgenograms taken in April, there was marked progress in the fusion of the two between April and October (as indicated in Figs. 1 and 2). Treatment, similar to that given previously, resulted in a prompt disappearance of all symptoms.

It may be of interest to mention the fact that this boy was the son of a famous football coach and that his first cousin had had bilateral Schlatter's disease a year previously.

As no case with similar clinical or roentgenological features had ever come to our attention, a search of the literature was therefore undertaken in an attempt to determine whether or not any similar lesion had been hitherto described. Nothing was found in either the English or German literature which seemed to have a bearing upon the subject, but articles by two Scandinavians were discovered, in which each author independently described precisely the same condition.

In 1921, Dr. Sinding Larsen (14), recorded as a new clinical entity the case histories and

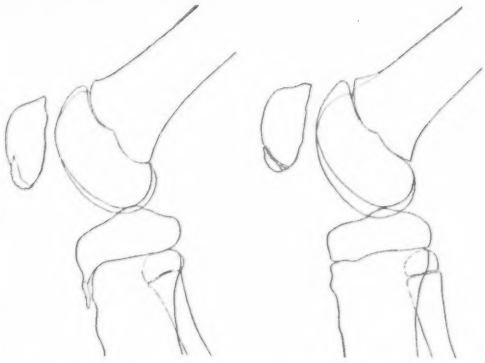

Fig. 1. Case 1. Roentgenogram tracings illustrating the appearance of both knees in April, 1927. The left knee (with symptoms) shows an accessory center of ossification at the lower pole of the patella; also the beak-shaped tibial epiphysis with fragmentation (symptomless) present in Osgood-Schlatter's disease. The right knee (symptomless) shows even more clearly the separate center of ossification in the patella. Here the tibial epiphysis is normal in shape.

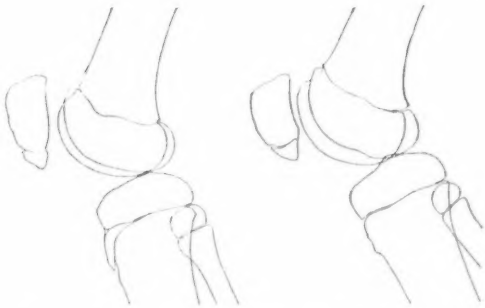

Fig. 2. Case 1. Roentgenogram tracings of the same knees as shown in Figure 1, 7 months later. The left knee shows fusion of the accessory center of ossification in the patella which is now well advanced. The beak-shaped tibial epiphysis has also partly fused with the diaphysis. The right knee shows the progressing fusion of the separate center of ossification but at a less rapid rate than in the left knee.

roentgenograms of two otherwise healthy girls, aged 10 and 11 years, respectively, who after overstraining themselves by dancing and jumping, had complained of pain in their knees. When the patients were seen by the author the affection was in each case clinically unilateral; the lower pole of the affected patella was painful on pressure, and in one of the cases the soft parts over and below the patella were slightly swollen. In the roentgenograms of the knees taken in profile, the anterior and lower outlines of the painful patellæ were hazy, with abnormal calcium deposits or bone shadows in the periosteum below the patellar apices. The author interprets these findings as indicating epiphysitis caused by overstrain, and offers in support of his conclusions the findings of a mild Schlatter's disease of the tibial apophysis (without symptoms) in one of the cases. The roentgenograms of the healthy knee in both cases showed similar abnormalities in a lesser degree. The first case was treated by immobilization in plaster for 6 weeks; the second, with rest without fixation. In each case a complete recovery both clinically and roentgenologically resulted after 6 months of treatment.

In 1922, Dr. Sven Johansson (8), unaware of Larsen's paper, reported the same condition as an apparently unknown lesion of the patella. Four cases were recorded by him as follows:

Case 1. A girl, aged 12 years, complained of the gradual onset of pain in both knees. For 2 or 3 months the pain had been worse after gymnastic exercises. Examination showed tenderness and some swelling over the lower poles of both patellæ, especially the right. The roentgenograms showed a separate irregular center of ossification at the lower pole of each patella, more clearly defined on the right. This side also showed the roentgenographic pictures of a typical Schlatter's disease of the tibial tuberosity, although clinically symptomless. On the left where the patellar changes were less marked, the tibial apophysis was normal in appearance. Treatment by rest and support resulted in a complete recovery in 3 months. Roentgenograms at this time showed the apices of the patellæ to be somewhat plumper than normal but there was complete fusion of the separate centers of ossification.

Cases 2 and 3. Two boys, aged 13 and 12 years respectively, developed knee-pain after vague injuries incurred several months previously. In Case 3 the characteristic roentgenographic changes of Schlatter's disease were present upon the affected side although no clinical symptoms were present.

Case 4. A girl, aged 13 years, had pain for 2 years, but it was confined to one knee.

Each of these patients made a prompt and complete recovery after the knee had been relieved from strain for a month or two.

From a consideration of these 6 cases and the 1 which we have reported, several points of interest appear worthy of mention. In the

first place, the age distribution is restricted to the period of most active growth, that is, from 10 to 14 years, and the symptoms apparently develop only in children who lead an especially active life. Second, in 2 of the cases with unilateral symptoms, roentgenograms of the apparently normal knee in each case showed identically the same changes but to a lesser degree. Third, it seems of some significance that in 4 of the cases the typical roentgenographic changes in the tibial apophysis present in Osgood-Schlatter's disease should exist, without symptoms. Fourth, the X-ray changes of these 2 lesions involving the upper and lower points of attachment of the patellar ligament, are very similar.

According to Adams and Leonard (1), the patella is not infrequently subject to anomalies in development. Ossification commences at the age of 5 or 6 years and the development is usually from one center. However, congenital anomalies with two or more centers of ossification are more common than generally supposed and are frequently mistaken for fracture. Such anomalies are usually bilateral and, eventually, the various centers usually fuse more or less completely to form one bone. The usual site of such an accessory center of ossification is at the outer margin of the patella, as first pointed out by Kempson (9) in 1922. In some instances, instead of fusing with the main bone, the ossification persists as a separate center and thus has been frequently mistaken for vertical fracture of the patella, as pointed out by various authors from time to time. In 1920, McNally (23), in a study of a large series of patellæ obtained from cadavers, found that 3 per cent had a more or less marked defect at the upper outer margin of the patella with or without a true accessory center of ossification at this site. He found that such defects of ossification were bilateral in two-thirds and unilateral in one-third of the cases. Of special interest in the large number of anomalous patellæ which he describes is one with a definite partially-fused separate center of ossification at the attachment of the patellar ligament to its lower pole. So far as could be ascertained, no earlier mention of a center of ossification at this site had been made in the literature.

Many theories as to the etiology of Schlatter's disease have been advanced by various investigators since it was first described in 1903. One group consider it to be a purely local, non-traumatic lesion and describe it variously as: apophysitis tibialis adolescentum (Alsberg in 1908); osteochondritis secondary to prepatellar bursitis (Kienboeck in 1910); epiphysitis tibialis dessicans (Ebbinghaus in 1913); irregular periosteal growth (Peteri in 1913); and infectious periostitis (Graf in 1915).

A second group consider Schlatter's disease only as a part of a generalized affection of the bones and joints. This is termed: a general disturbance of ossification (Lanz in 1905); late rickets (Jakobstal in 1907); a deformity from disturbances of growth (Bergmann in 1909); and a systemic disease characterized by periosteal separation and general ligamentous weakness (Schulze in 1913).

The purely traumatic theory of etiology was advanced by Altschiel, in 1918, but few are willing to subscribe to this theory. In 1920, Mueller, after a thorough and impartial review of the whole question, advanced the reasonable hypothesis that trauma *per se* was not the original cause but only acted on a pre-existing weak spot due to local or generalized irregularity in growth. In support of his contention, he reported a case of bilateral Schlatter's disease with marked roentgenological findings (though mild clinical symptoms) which showed similar changes in the lesser trochanters, more pronounced on the right than the left, and also in the lower pole of one patella in which there was irregularity of outline and periosteal elevation entirely without clinical symptoms. From this he concluded that Schlatter's disease was a local manifestation of a systemic process characterized by a tendency to pathological epiphyseal injury brought about by the strain of attached ligaments and tendons without noteworthy traumatism. If he is correct in his assumption, it would seem logical to conclude that Larsen-Johansson's disease is another such local manifestation which develops at the site of an occasional anomalous epiphysis in the patella. It is interesting to note that Lewin (16), in a recent discussion of apophy-

sitis of the os calcis, states that he believes that this constitutes another lesion of a similar nature, involving an epiphysis which serves as an attachment for a large tendon.

CONCLUSIONS

In the authors' opinion, a clear parallelism exists between Larsen's and Schlatter's disease. In each instance there is anomalous bone formation—in the latter, the beak-shaped tibial epiphysis, in the former the accessory center of ossification at the apex of the patella. Therefore, it is natural to believe that a potential mechanical weakness exists at the lower end of the ligamentum patellæ in the one case, at the upper end in the other. We believe that the two lesions are not usually associated with sudden trauma, but are the result of continued strain on the patellar ligament which not infrequently occurs during such vigorous exercises or games as horseback riding, football, jumping, etc. Furthermore, the clinical signs and symptoms, roentgen findings, course, prognosis, and treatment are so similar that the analogy appears complete.

The authors believe that the two diseases are essentially traumatic, resulting from a strain of the patellar ligament which is in itself potentially strong, but in both Osgood-Schlatter's and Larsen-Johansson's disease is attached below or above into a weak point of anchorage.

The diagnosis is based essentially upon the finding of a definite circumscribed point of tenderness over the lower tip of the patella, and the detection by roentgenological examination of a separate center of ossification at this site. This case emphasizes the value of giving due recognition to the common physical sign of a sharply defined point of localized tenderness, and the necessity for careful investigation for the cause of the tenderness.

The late Dr. Lewis A. Stimson for many years emphasized the importance of the sign of local tenderness in diagnosis, pointing out that this physical test was the most valuable one in detecting a fracture, sometimes the only sign present, and the test which most accurately defined the site of the fracture. He was an acknowledged genius in localizing injuries of the bones by physical examination.

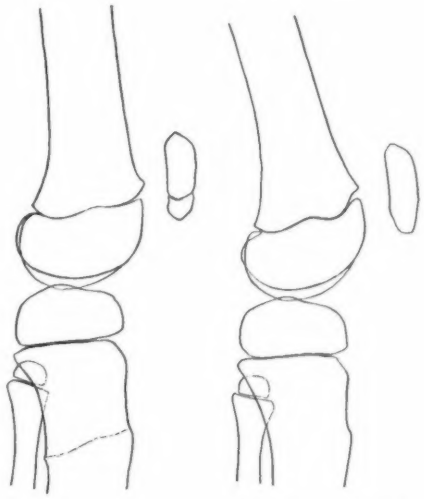

Fig. 3. Case 2. Roentgenogram tracings of both knees, December, 1927. In the left knee, the patella shows a well marked anomalous center of ossification at the lower pole. There is also an impacted fracture through the head of the tibia. The patella of the right knee is normal.

In the authors' opinion the meticulous examination for the detection of localized tenderness has been productive of bringing to light many lesions which were previously poorly understood, such as epicondylitis of the elbow, strain of the rhomboid muscles at their attachment to the scapula, fractures of the bones of the carpus and tarsus, sprain of the gluteal muscles, and similar lesions. We believe that it is not illogical to suppose that beneath a sharply defined point of local tenderness over muscles, ligaments, or bones there exists a definite injury to one of these structures (in the absence of any infectious process or disease) especially with the history of trauma, indulgence in active forms of sport, or an occupation where unusual strain is exerted on a certain part of the body. This point of view and the habit of attempting accurately to localize points of tenderness, perhaps sometimes overdone, were responsible in this instance for the detection of the lesion.

ADDITIONAL CASE REPORTS

More recently another case of this affection was discovered in a boy who sustained a greenstick fracture of the upper end of the tibia with almost no

deformity. He had stepped in a hole and fallen, subjecting his knee to a sudden severe strain. He continued to walk for several days but with a considerable limp which did not improve. He then consulted the family physician who found a line of cleavage at the lower pole of the patella as determined by a roentgenogram (Fig. 3) and made the diagnosis of fracture of the patella. He was referred to us on November 14, 1927. On first examination the symptoms were all referred to the patella and there was distinct local tenderness over its lower pole. More careful examination demonstrated, in addition, a greenstick fracture of the upper end of the tibia. It was an interesting fact, however, that the degree of tenderness over the site of fracture was much less acute than over the lower margin of the patella, and that the disability, to all appearances, was due to weakness at the attachment of the patellar ligament to the patella rather than to the fracture which was firmly impacted and provided sufficient stability for weight bearing.

TERMINOLOGY

The authors have taken the liberty of designating this lesion as "Larsen-Johansson's disease of the Patella." They have done so with the idea of conforming to modern usage, as exemplified by the accepted terms: Osgood-Schlatter's disease of the tibial tubercle, Koehler's (12) disease of the tarsal scaphoid, Legg-Perthes' (15 and 19) disease of the femoral head, and Kienboech's (11) disease of the carpal semilunar as first described in English by Dr. Kellogg Speed.

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CLINICAL SURGERY

FROM THE NEUROSURGICAL CLINIC OF THE UNIVERSITY HOSPITAL

THE RADICAL OPERATION FOR THE RELIEF OF TRIGEMINAL NEURALGIA

By CHARLES H. FRAZIER, M.D., Sc.D., F.A.C.S., and W. J. GARDNER, M.D., Philadelphia

SINCE 1898, when Spiller first proposed section of the sensory root as a substitute for excision of the Gasserian ganglion, the sensory root operation has been the accepted procedure the world over. However, certain modifications have been made in the operative details since that time. In 1918 it was proposed, and the suggestion has since been accepted, that the motor root should be conserved. Still later it was found unnecessary to sacrifice the entire sensory root, so that what has come to be called "subtotal section of the root" is now accepted as the proper procedure. For example, if the pain is not referred to the ophthalmic distribution the inner fibers of the root are not divided. The importance of this innovation in absolutely eliminating trophic keratitis only needs be mentioned.

The operation carries with it unqualified assurance against recurrence; the hazards of the operation have been so reduced that the mortality rate is less than one-half of 1 per cent.

Generally speaking there is no operative field with more frequent anatomical variations, with more variations as to amount of hæmorrhage, and with a wider range as to what might be regarded as an operation devoid of any great technical difficulty. It is so beset with puzzling situations, that only with a background of wide experience, can one approach the next operation with a sense of confidence. Even with an experience of 520 operations in the Neurosurgical Clinic of the University Hospital, certain new pictures present themselves.

PREPARATION OF PATIENT

A careful physical examination is made, including a renal function test. A blood pressure observation is made in all cases. When the blood pressure is 200 or over, the patient may receive an alcoholic injection. With rest and relief of pain the blood pressure is often reduced. Again an alcoholic injection may be given as preliminary treatment when, because of pain on swallowing the patient may be improperly nourished, or, from lack of sleep, exhausted. A week of rest with proper attention to diet and water intake has a very beneficial effect.

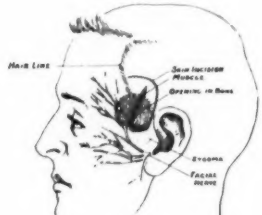

Fig. 1. The relationship of facial nerve to incision, left side.

Fig. 2. Location of skin incision with relation to ear, right side.

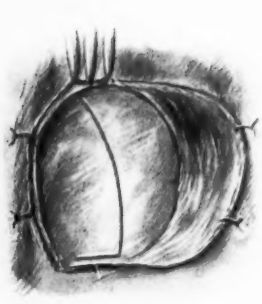

Fig. 3. Cutaneous flap reflected. Line of incision in temporal fascia and muscle, right side.

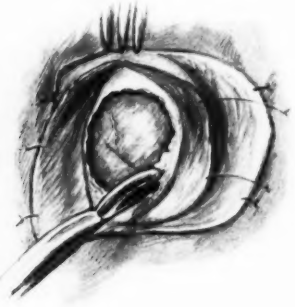

Fig. 4. Muscle flap reflected and sutured to draperies. Dura separated from bone. Bone being removed.

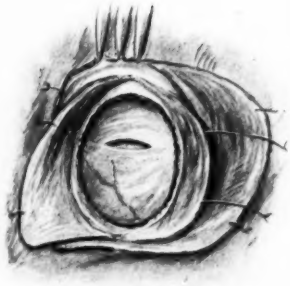

Fig. 5. Incision in dura to allow cerebrospinal fluid to escape and thus decrease volume of intracranial contents.

As a precaution against keratitis, 1 drop of 1 per cent solution of atropin sulphate is instilled in the eye the night before and the morning of the operation.

The hair is shaved only from the temple, about 8 centimeters above the zygoma and posteriorly to a perpendicular line through the mastoid process. Twenty minutes before the operation the patient is given the usual pre-operative hypodermic, 1/6 grain of morphine sulphate and 1/150 grain of atropin sulphate.

THE OPERATION

The various steps of the operation are depicted in the accompanying illustrations. As one sees the structures on the operating table, the illustrations do not seem to portray the picture faithfully. In various attempts to secure accurate reproductions, the artists have failed to give the proper perspective and seem unable to represent the anatomical details accurately. However, the illustrations here reproduced will serve at least as a guide to the text.

Position of the patient. Preference is given to the sitting position for several reasons: there is less bleeding, the patient requires less ether, and the field of operation is on a level with the eyes of the operator.

Anæsthetic. The anæsthetic of choice is ether, administered by the open drop method. The anæsthesia is begun while the operative field is being prepared and generally the patient is anæsthetized by the time the draperies are in position. As soon as the ganglion is exposed, it is injected with 1 cubic centimeter of 2 per cent solution of novocain, the ether discontinued, and the operation concluded under regional anæsthesia. The time consumed in exposing the ganglion is usually about 20 minutes, so that but little ether is required. This operation might

Fig. 6. Foramen spinosum being plugged with cotton to obliterate the middle meningeal artery.

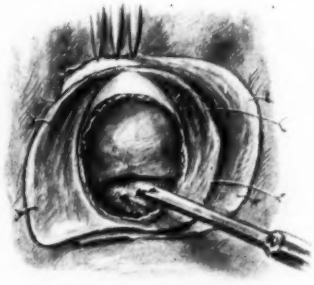

Fig. 7. Middle meningeal vessels cut. Bony prominence being chiseled away to afford a better view of third division.

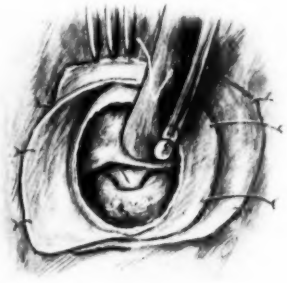

Fig. 8. The third division is exposed and dura separated from superior surface of ganglion.

Fig. 8, a. A line of incision in dural sheath of ganglion (larger scale).

Fig. 8, b. Dural sheath opened. First and second divisions indicated by dotted lines (larger scale).

quite well be performed under local anæsthesia, but a general anæsthetic is preferred by the patient. Subjects of trigeminal neuralgia usually have reached the limit of human endurance and dread the thought of additional discomfort. The use of ether in such small quantities in no way adds to the risk of operation.

The cutaneous incision is composed of a horizontal limb a little over 1 centimeter in length, along the superior border of the zygoma and about half a centimeter in advance of the tragus of the ear, and of a vertical limb extending upward about 4.5 and curving forward 2 centimeters (Fig. 1). Pressure by the assistant on the temporal artery, where it crosses the zygoma, will keep the field bloodless while the cutaneous incision is being made. As the temporal artery is cut across in the lower horizontal limb, it is grasped with a hæmostat. The resulting skin flap is dissected free of the underlying tissue, reflected forward, and sutured to the draperies, thus avoiding the use of a self-retaining retractor (Fig. 2).

Musculo-aponeurotic incision. An incision is made in the temporal fascia and muscle—just the reverse of the cutaneous incision (Fig. 3). The resulting musculo-aponeurotic flap after it has been separated, with the pericranium, from the temporal bone is reflected backward and sutured to the draperies. Thus a sufficient area of temporal bone is exposed without the use of retractors. This incision is so designed to be quite within the hair line and to avoid injury to the superior branch of the facial nerve.

Removal of bone. A small perforation in the skull is made with hammer and chisel below the level of the middle meningeal artery and the opening enlarged with rongeur forceps (Fig. 4). An opening 4 centimeters in diameter usually is ample. The lower margin of the opening must correspond to the base of the skull.

Separation of dura. The separation of the dura from the skull without laceration may be very difficult, especially as one approaches the base of the skull, where it is most adherent and of most delicate texture. When the dura is snugly adherent, it is advisable to begin the separation on either side of the cranial defect. A small perforation is made in the dura in the center of the exposure to allow the escape of cerebrospinal fluid throughout the operation (Fig. 5). This reduces the bulk of the intracranial contents and thus facilitates the elevation of the temporal lobe. With gentle pressure by means of an illuminated brain retractor especially designed for this operation, the operator commences to separate the dura from the floor of the middle fossa. Usually this is readily accomplished with a septal elevator, but occasionally the dura is so adherent that lacerations of the dura may be unavoidable.

The operative field, at this stage, is kept bloodless by means of a specially designed, curved metal aspirator and by the judicious use of dental cotton tampons.

Approach to the ganglion. The first landmark is the groove of the middle meningeal artery on the floor of the fossa. When this is seen, the operator follows it to its termination at the foramen spinosum where the dura is separated gently to avoid rupture of the artery, sufficiently fore and aft of the foramen to permit a clear view of the artery as it emerges from the foramen. The middle meningeal artery and foramen is thus exposed with a small dental applicator, and the

Fig. 9. Sensory root displaced upward to show motor root as it passes behind ganglion to join the third division (larger scale).

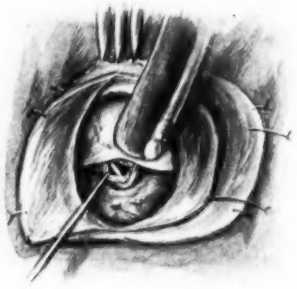

Fig. 10. The outer two-thirds of the sensory root is picked up on a hook, ready for section. Motor root behind.

foramen is plugged with a wisp of cotton so as to obliterate its lumen (Fig. 6). The artery and vein are then divided with a scalpel.

Exposure of the ganglion. The next objective is the mandibular division of the trigeminal nerve as it enters the foramen ovale. This foramen lies just mesial and a little anterior to the foramen spinosum, and is partly hidden from view by a small bony eminence on the floor of the fossa. This eminence is removed with a chisel (Fig. 7).

The next step of the operation is the most important and sometimes the most difficult. The dura must be separated from the sheath of the ganglion. Often the line of cleavage is difficult to find, or the dura may be intensely adherent to the ganglion's sheath. One must avoid perforating the dura or penetrating the sheath. For this separation, a septal elevator combined with a suction apparatus all in one will be found helpful, and pressure is made directly over the foramen ovale until this line of cleavage becomes manifest (Fig. 8). The dura is separated from the surface of the ganglionic sheath as far forward as the maxillary division, and backward and inward until the arachnoid covering of the sensory root comes into view. One cubic centimeter of 2 per cent novocain is injected into the ganglion, the ether is discontinued, and the operation concluded under regional anæsthesia.

Exposure of the sensory root. One should be familiar with the appearance of the line of junction between the ganglion and root. It is usually readily recognized in various ways and the dura must be dissected far enough mesad so that an ample exposure of the root may be obtained. The facility with which fractional division of the root is accomplished will depend upon the liberality of this exposure. Without such exposure the nicety of the subsequent steps is an impossibility. To expose the root, an oblique incision is made in the dural sheath parallel and a little in front of the posterior margin of the ganglion (Fig. 8, a). The sheath is bluntly separated on either side of this incision and the sensory root is exposed to view (Fig. 8, b).

Exposure of the motor root. When the sensory root is elevated the motor root may be seen on the floor of the skull as a separate isolated fasciculus. Sometimes the motor root is composed of two fasciculi. It is quite separate and distinct from the sensory root and may be seen to pass behind the ganglion. If there is any question about its identity, it may be identified by stimulation with an electrode (Fig. 9).

Section of the sensory root. There remains now only to section as much of the root as may be required in the individual case. The upper and inner third of the root supplies the ophthalmic division; the lower and outer third, the mandibular division; and the intermediate fibers, the maxillary division. As in most cases pain is referred to the maxillary and mandibular divisions, this portion of the root must be sacrificed. Section of the necessary fasciculi is readily accomplished with a small scalpel after the fasciculi have been isolated on a specially designed blunt hook (Fig. 10).

Hæmostasis. There are only three sources of hæmorrhage that may require attention: (1) A small dural sinus which may be injured when the dura is separated from ganglion in the neighborhood of the second division. To control this a tiny muscle graft is sufficient. (2) The peripheral stumps of the middle meningeal vessels which

are clamped with two Mackenzie silver clips. (3) Oozing from the middle meningeal artery in its groove in the antero-inferior angle of the parietal bone. To control this it is usually sufficient to separate vessel and dura entirely free from the skull at this point.

Wound closure. Bleeding, no matter how slight, should be completely controlled before the wound is closed. The tiny dural incision and any incidental laceration of the dura should be sutured. The wound is then closed with interrupted sutures in each tier, temporal muscle, temporal aponeurosis, galea, and skin.

POSTOPERATIVE CARE

The immediate convalescence as a rule is free from any great discomfort. Sometimes nausea and vomiting may disturb the patient for 24 hours. These are probably of central origin and are not affected by medication. Five hundred cubic centimeters of a 5 per cent solution of glucose is given by enteroclycis should there have been much oozing during the operation. A postoperative headache will yield to aspirin or codein. If the entire root has been sacrificed, corneal complications may be prevented by keeping the lids closed and continuing the installation of atropin for 4 days, with irrigations of boric acid solution 3 times a day. The head and shoulders are slightly elevated. A cathartic is given on the evening of the first postoperative day and an enema in the morning. The patient is allowed to get up on the fifth day, when the stitches are removed.

FROM THE DIVISION OF SURGERY, MAYO CLINIC

AN ASEPTIC METHOD OF INTESTINAL ANASTOMOSIS[1]

By FRED W. RANKIN, M.D., F.A.C.S., Rochester, Minnesota

THE most fascinating chapter in the romance of surgery deals with operative maneuvers on the gastro-intestinal tract. In this chapter the paragraph on intestinal anastomosis represents the most intriguing development of the surgical art from the technical standpoint. The earnest endeavors of many men to increase the factors of safety in intestinal surgery indicate the search for an ideal which will provide for the removal of offending lesions, for the restoration of physiologic equilibrium without contamination, and with the lowest compatible mortality and morbidity. The multiplicity of operative procedures and the evolution of all abdominal operations testify amply to the importance as well as to the interest in such adventures. This desire to develop a clean type of anastomosis has resulted in multiple devices and methods, many of which recommend themselves from their very ingeniousness and many, because of their innate cumbersomeness, are doomed to disfavor.

Kerr, in a classical paper read before the Section on Surgery of the American Medical Association in 1923, traced the development of intestinal surgery from the earliest records up to the present time. He commended Lanfrank's *Science of Cirurgie*, published in 1396, which outlined the treatment of intestinal wounds and called attention to types of sutures and their application. Prior to this the occasional spontaneous recovery from intestinal perforation, caused by battle wound or accidental penetration, had resulted from the agglutination of the peritoneal coats of the intestine against the parietes, preventing effusion and contamination. In 1812, Travers published a series of experiments on animals showing that intestinal wounds healed by agglutination, and called attention to the fact that this process had been known to the medical profession for more than four hundred years. The suturing of the peritoneal edges of the wound in 1826 by Antoine Lembert of Paris, whose name is still associated with intestinal suture, put into practice the principle that intestinal wounds healed by adhesion of the inverted peritoneal coats; thus a fundamental principle was established which has been largely responsible for the successful evolution of this branch of surgery. Murphy's button in 1892, marked another advance subsequent to which intestinal resection became popularized. Kerr asserted that there have been about 250 different methods of intestinal sutures described in the last century, and he himself offered a most admirable aseptic anastomosis which answers all the fundamental requirements and is readily accomplished. His basting stitch method has proved very satisfactory in my hands; I feel sure that it is one of the most serviceable types of clean intestinal anastomosis.

Fraser stated that after Halsted's pioneer attempts to develop aseptic anastomosis following intestinal resection, thirty-two separate and distinct methods have been proposed. Failure of these methods to become universally adopted is due mainly to four reasons: (1) the disregard of many vital fundamental principles of intestinal surgery in the desire to accomplish a perfect operative procedure; (2) the lack of simplicity in most of the methods prescribed; (3) anatomical differences denying adequate vascularization to the resected ends, unrecognizable because of the necessary blind method of joining the bowel; and (4) failure to recognize that the large bowel, in which three-fourths of the resections are necessarily performed, is highly permeable under obstructive conditions, and that its manipulation is often followed by peritoneal contamination due to the spread of organisms through the bowel wall despite the fact that the resection and anastomosis have been done in a thoroughly aseptic manner.

The differences in the anatomical construction of the large and small divisions of the bowel influence considerably the technical maneuvers applicable to each. The large bowel is much thinner than the small bowel, and its tunica propria, which is beneath the endothelial layer of epithelium and which contains lymphatics and blood vessels, is often replaced by fat. Under chronic obstructive conditions, its normal permeability is greatly increased and absorption and infection take place. The peristaltic action of the large bowel is definitely more powerful than that of the small bowel, so there is more likelihood that strain on the suture line will cause leakage.

The blood supply of the large bowel, in each of its divisions is often inconstant, and the anastomosing arcs frequently uncertain. The right half

[1]Submitted for publication May 17, 1928.

around to the middle of the transverse colon receives its blood supply from the superior mesenteric vessels, together with the rest of the absorptive portion of the gastro-intestinal tract, and the left half which is concerned mostly with storage, receives its blood supply from the inferior mesenteric branches of the aorta. The anastomosis between these two sources of supply is often incomplete or absent and for this reason failure of union with resulting necrosis and peritonitis may occur when the resection has been made in the distal arm of the transverse colon or the upper part of the descending segment. Another source of failure in the open method of intestinal anastomosis has been the invasion of the fat of the mesentery in the "V" where a wedge has been excised. Here necrosis is probably most frequently walled off and occasionally rupture through the suture line occurs into the lumen of the bowel, but more often abscesses result from leakage, infection, and failure of the anastomosis.

The healing of intestinal wounds has been splendidly dealt with experimentally by Halsted, Mall, Hertzler, and others. Regenerative changes, according to their experiments, demonstrate that the healing of the peritoneal wound takes place by direct transformation of lymph into connective tissue without passing through the granulation tissue stage if there is no infection. Agglutination of the resected ends under firm pressure is another principle of intestinal surgery which is advantageously employed in making a clean, closed anastomosis. Mall's experiments showed that under pressure the diaphragm, which is a result of turning in the margins, becomes destroyed by necrosis and at the end of the fifth day the slough separates, leaving, usually, a clean surface. The muscularis mucosa is completely regenerated at the end of about 3 weeks, and the raw surfaces of the anastomosis are covered over. The sloughing away of this diaphragm sometimes has been accompanied by secondary hæmorrhage, occasionally fatal, but this is an exceptionally rare complication. Quick healing of intestinal wounds is due to approximation of the peritoneal surfaces and inserting suture material only deep enough to catch the submucosa, which is the important structure in the anastomosis. (Figs. 1 and 2.)

The clamp which I have devised I offer not with easy confidence that it will be adaptable for intestinal anastomosis under all conditions and circumstances, but with the hope that it may be a valuable addition to the surgeon's armamentarium. I feel that the simplicity of its arrangement and the ease with which it may be applied and manipulated commend it. I have found it extremely advantageous in joining the large bowel end-to-end or side-to-side, and the large and small bowel end-to-side. I have used it in twelve resections of the colon in which these three types of anastomosis have been carried out satisfactorily. Secondary hæmorrhage or the formation of a diaphragm in the lumen has not occurred in any of the cases. The good results, I believe, bear out the experimental advantages demonstrated by Graham in Mann's laboratory. In working on a series of dogs, he made the various types of anastomosis without leakage, hæmorrhage or the formation of a diaphragm. (Figs. 3, 4, 5 and 6.) I quote his report:

Fig. 1 (above). Clamp closed, bladed. Depth in this position is 8 millimeters. Length over all is 22.5 centimeters, each blade being 7.5 centimeters in length. Central blade is 0.5 centimeters in width and 3 millimeters in depth.

Fig. 2. Clamp with one blade closed and the other open for the reception of the bowel.

"A series of experiments was conducted in order to determine whether the Rankin clamp for closed intestinal anastomosis was more satisfactory than the usual open method. For this purpose two groups of operations, consisting of end-to-end, end-to-side, and side-to-side anastomosis on the colon were performed on dogs.

"In the first group, which served to demonstrate the virulent nature of the content of the colon, the colon was incised and anastomosed in the ordinary open manner. In the second group, the anastomosis was made with the special clamp. The use of protective packs to wall off the surrounding area was purposely avoided in both instances. Rubber-covered clamps were used, however, to prevent gross soiling in the open method. The carbolic and alcohol technique was applied to the end of the bowel within the Rankin clamp.

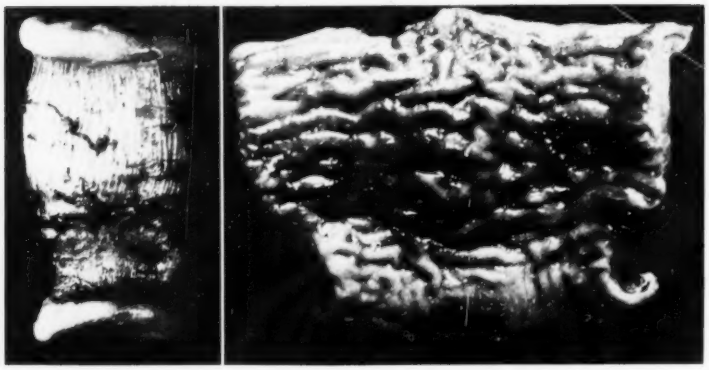

Fig. 3 (left). End-to-end anastomosis. Specimen unopened. Absence of bulging was observed at operation due to inequality in size of bowel.
Fig. 4. Specimen open. Complete absence of diaphragm at site of operation.

"The results of the foregoing experiments were clean-cut. In the first control group all of the animals died of peritonitis within 5 days. In the second group there were no evidences of peritonitis and there were no deaths. Observations at subsequent operations, 6 to 8 weeks later, revealed that the anastomosis functioned satisfactorily; the bowel was not dilated proximal to the anastomosis. A study of the operative sites after their removal from the body elicited these facts: absence of circular constriction, almost complete absence of a diaphragm within the lumen, and absence of diminution in the diameter of the lumen.

"Such results prompt the conclusion that the clamp under consideration offers an entirely satisfactory closed aseptic method for anastomosing the large bowel in the dog. Furthermore, it is readily conceivable that the clamp should be even more applicable to operative procedures in man when one considers that the preceding results were obtained in spite of certain handicaps that the intestine of the dog offers to such procedures, namely, its relative smallness, thickness, friability, and tendency to contract on manipulation."

The instrument is a three-bladed clamp sufficiently short to facilitate adaptability. It is readily mobile and narrow enough to permit the

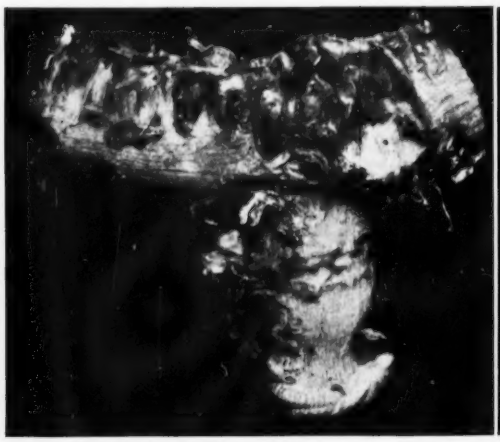

Fig. 5. End-to-end anastomosis. Specimen has not been opened.

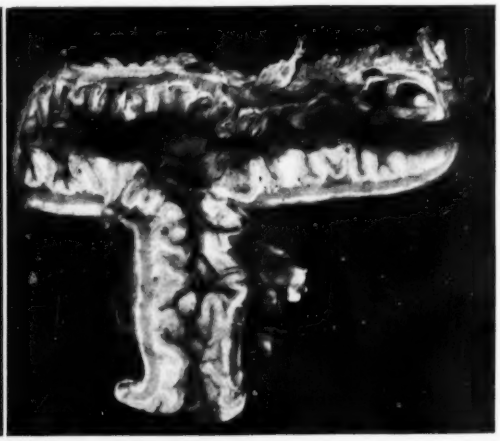

Fig 6. Sagittal view of end-to-side anastomosis. Complete absence of diaphragm at site of operation.

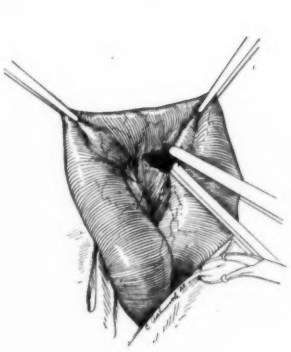

Fig. 7

Fig. 7. Application of clamp to ileum. The blood supply in the mesentery has beeen tied off and the clamp is applied at an angle so as to obtain a wider lumen for the anastomosis. The bowel is divided with cautery.

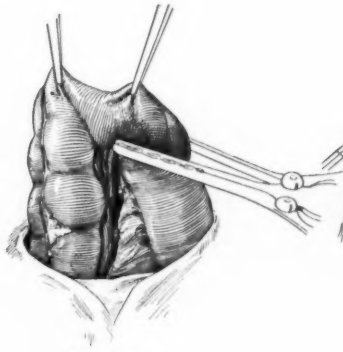

Fig. 8, a.

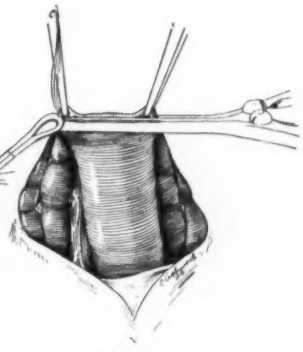

Fig. 8, b.

Fig. 8. a, The clamp is shown being applied to a point selected on the transverse colon for the colonic end of the anastomosis. b, An elliptical portion of the colon is being removed by cautery to make an opening in its lumen and the small bowel is shown approximated at this point.

advantage of the principle of agglutination between the peritoneal coats of the crushed bowel and at the same time to avoid excessive clumsiness which comes from the attempt to suture over a wide instrument. The central blade is the fixed point against which the two lateral blades operate independently. The fulcrum, which permits the steady pressure, is in the handle; there is a fulcrum on each side of the clamp. The length of the entire clamp from tip to tip is 22.5 centimeters. Each blade is 7.5 centimeters long and the central blade is 0.5 centimeters wide. It is 3 millimeters deep, and the blade portion when closed is 8 millimeters deep. When the clamp is in use the posterior peritoneal coats of the two arms of the bowel are in direct approximation, separated only 0.5 centimeters by the central blade, and the anterior surfaces of the two limbs of bowel to be anastomosed are separated by the entire thickness of the clamp. Firm pressure and agglutination keep the limbs of the resected ends in accurate apposition after the application of the suture which covers the point of the clamp but which necessarily is not drawn tight over the handle portion until its withdrawal. On withdrawal of the clamp the end suture is put in and the whole line of sutures on the anterior surface is drawn taut without contamination. The diaphragm must be broken out with the fingers through the lumen.

Control of hæmorrhage is dependent on the crushing of the vessels, and occasionally, perhaps, secondary hæmorrhage may take place. It has not occurred in the cases in which I have used the clamp, and I believe that it is a much overestimated danger in closed anastomosis. The formation of a diaphragm after operation has not been observed in the experimental laboratory or in a series of resections on human beings.

It may be well to discuss the three types of anastomosis somewhat more in detail. In an operation on the large bowel, for carcinoma or any other lesion that has produced long-standing obstruction, the two-stage resection should practically always be performed. I am convinced that this should always be carried out in the left segment of the colon, but certain conditions in the right segment may make it advisable to perform the one-stage operation. However, carcinoma in either arm of the colon presents a somewhat different problem from tuberculosis, stasis or other lesions that require surgical intervention, and since surgery of the colon is usually directed toward the eradication of malignancy, I have gradually come to believe that all carcinomata of the colon, if they are causing any obstruction whatever, should be operated on in two stages.

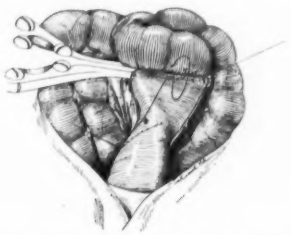

Fig. 9. Posterior layer of sutures being applied in end-to-side anastomosis. Clamp is turned over.

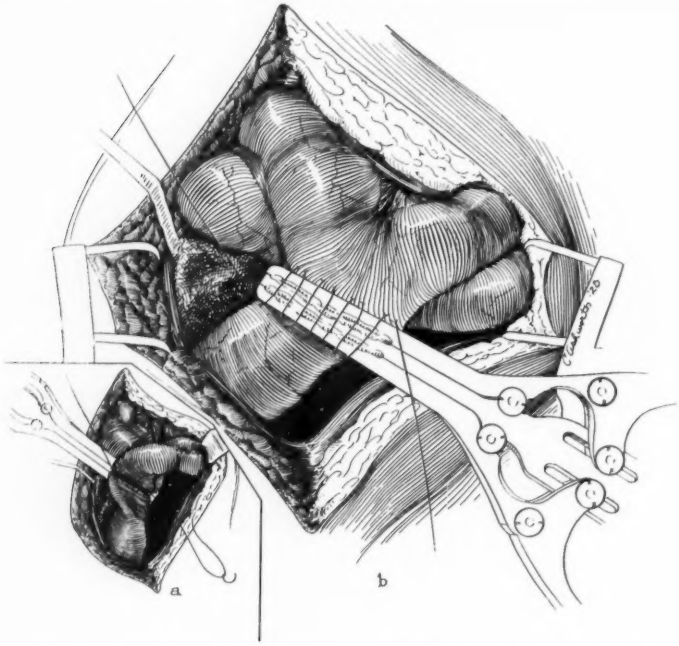

Fig. 10. Ileocolostomy over a clamp. a, Posterior layer of sutures anastomosing the ileum and transverse colon. b, Anterior layer of sutures.

ILEOCOLOSTOMY

I have used the clamp in performing ileocolostomy in the right half of the colon between a suitable site in the transverse colon and a point in the ileum about 32 centimeters from the ileocæcal valve. In order to secure as large an opening as is desirable, the clamp is put on the small bowel at an angle and the bowel is cut across, the end toward the cæcum being invaginated by a purse-string suture, and dropped back, to be removed with the colon at the subsequent resection. An elliptical piece of the transverse colon is removed with the cautery after the application of the clamp to the selected site. The clamp and the mobility of the bowel permit easy handling, and the sutures are first put in on the posterior side of the bowel, which may be brought under the eye by turning over the whole clamp. This permits the accurate approximation of the peritoneal coats of the bowel on the under surface of the anastomosis because here the two arms of the bowel are in juxtaposition. After this suture is in place the clamp is again reversed and the anterior line of sutures applied in a manner identical with that employed in closing the duodenum following partial gastric resection. The sutures at one end of the clamp have drawn the bowel together over this end and the clamp is now released and withdrawn. The agglutination of the two ends of bowel under the steady pressure keeps it intact

Fig. 11. Operation completed. The distal end of the lumen is turned in and dropped back into the abdomen while the proximal end is anastomosed end-to-side with the transverse colon.

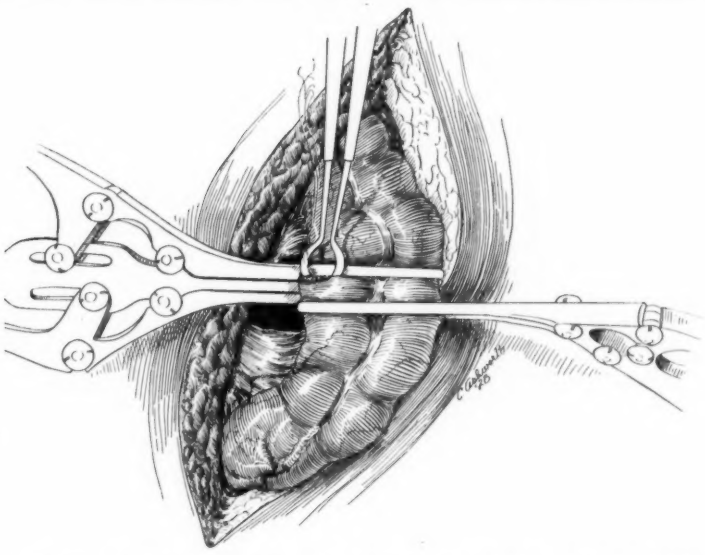

Fig. 12. Division of bowel proximal to the growth, one limb of the clamp holding the end to be anastomosed, the other limb shown closed.

and the anterior layer of sutures is pulled taut and tied. Leakage at this stage has not occurred in any of my cases. Another layer of silk sutures is inserted around the entire area of anastomosis, and the fat tags and omentum are wrapped around it to guard against contamination and leakage. The fingers of one hand are invaginated through the anastomosis to break out the agglutinated ends and prevent obstruction. The secondary resection of the colon takes place in about two weeks.

END-TO-END ANASTOMOSIS

I have usually employed this method of end-to-end anastomosis in the sigmoid, but I applied it in two cases of growths in the descending colon and in one case of carcinoma in the transverse colon. Drainage procedures were carried out in all cases preliminary to the resection and anastomosis. Certain portions of the sigmoid, in which more carcinomata occur than in any other segment of the colon, offer ideal sites for resection and anastomosis. I am not discussing here the growths low in the sigmoid or in the rectosigmoid because of the questionable desirability of re-establishing the intestinal continuity when carcinoma has invaded this portion of the gastro-intestinal tract. One is frequently loath, however, to make a permanent colostomy in the middle and upper part of the sigmoid, and subsequently to resect all the bowel distal to it; in such cases the clamp anastomosis may be carried out most satisfactorily. In this situation one may practically always be certain of the adequacy or inadequacy of the blood supply to both ends, since it may actually be seen. The end-to-end anastomosis is readily accomplished over the clamp in much the same manner as the end-to-side anastomosis, the clamp being put on the bowel with the handle away from the operator, thus making the posterior suture line more readily accessible following resection. I have found it advisable in most instances to place the clamp superimposed by a small Payr clamp on the upper end of the bowel to be resected, and to cut between the two with the cautery. This permits one to gauge the exact amount of bowel below which may be sacrificed, with the possibility of establishing anastomosis without tension and with adequate blood supply to the ends. Having satisfied oneself on these two points, a similar maneuver is carried out on the distal end, and again the resection with the cautery leaves the bowel ready for anastomosis over the clamp. Occasionally, if the bowel is freely movable and inspection can be carried out rapidly, both ends of the bowel may be caught in the clamp, one clamp being used above for the resection. Fat tissue should be removed from the immediate vicinity of the suture line, but once the anastomosis is made, such structures as

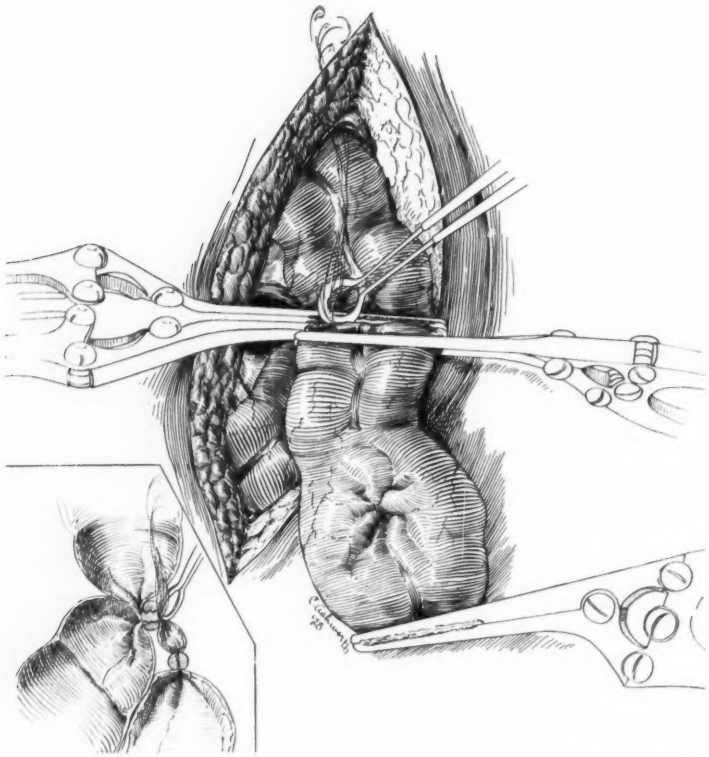

Fig. 13. Resection is being completed with cautery. Both arms of the bowel are caught with the clamp and the section is shown being removed.

omental tags are sought and sutured over the line to give it additional strength. In resection of the sigmoid the bowel should always be returned into the peritoneal cavity. In the ligation of the blood vessels supplying this segment of the bowel, it is necessary to dissect the peritoneum of the mesentery from both sides, in order to reach the vessels satisfactorily. This leaves two layers of peritoneum which may be approximated after the resection and on which the anastomosed bowel may lie. This is an additional protection to the suture line and peritoneum from the lateral parietes or, if the anastomosis lies deep in the pelvis, from the bladder or from the broad ligaments in the female. The anastomosed bowel should always be attached to the suture line to re-enforce it and establish every precaution against leakage. After the anastomosis has been completed, the diaphragm, at the point of union, is broken out by invaginating the finger through it, and the abdomen is closed without drainage. I am confident that this step is exceptionally important, and experience in a case of growth low in the sigmoid in which anastomosis was carried out and which could be mobilized only by the clearing out of the entire hollow of the sacrum and the separation of the growth from its attachments in front, encourages the belief that such a conclusion is correct. In this particular instance there was a dead space in the hollow of the sacrum, and a tube with a wick of gauze was placed for drainage. The patient's convalescence was stormy, which, because of the subsequent drainage without leakage of the bowel, was believed to be due to the tube in the pelvis. Since then I have always closed the abdomen tightly and have not regretted it in any case.

COLOCOLOSTOMY

Lateral anastomosis in the large bowel is probably most often indicated between the arms of the transverse colon or between the transverse

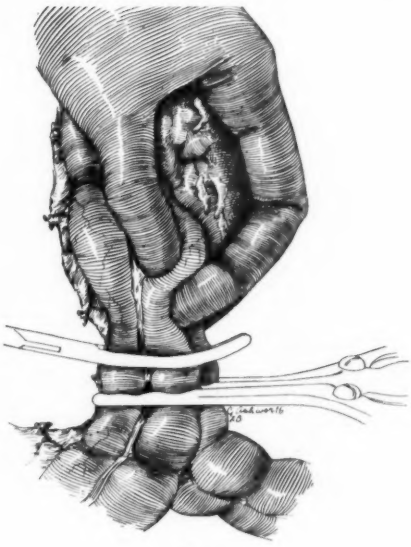

Fig. 14

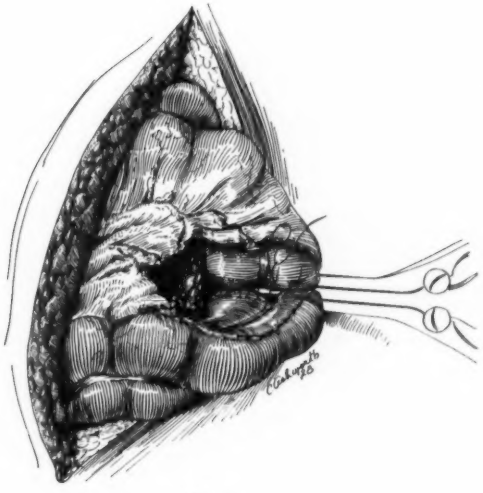

Fig. 15

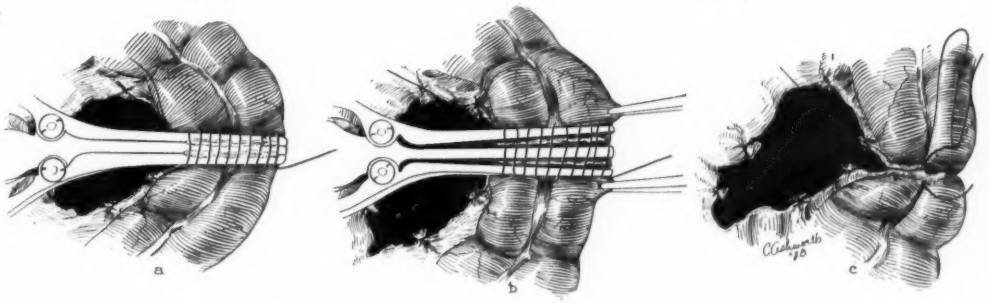

Fig. 16

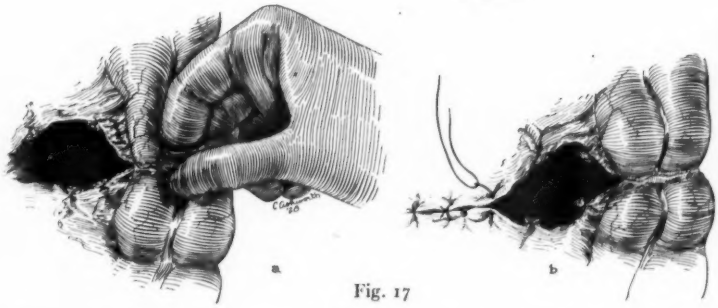

Fig. 17

Fig. 14. Segment ready for removal with cautery. One clamp above the anastomosis line catches both limbs of the bowel to be removed.

Fig. 15. The first layer of sutures is being applied posteriorly. Clamp is rotated laterally and a continuous catgut suture approximates the peritoneal coats of the bowel on the posterior side. This suture extends half way across the bowel.

Fig. 16. End-to-end anastomosis over clamp. Resection has been made. a, Suture applied on anterior side of the bowel with continuous peritoneal stitch. b, Clamp unlocked ready to be withdrawn after which the suture will be drawn taut, inverting the end of the bowel. c, Completed operation and final row of sutures being put around the anastomosis.

Fig. 17. a, The fingers introduced through the anastomosis to break up the agglutination which forms a diaphragm. b, The operation is completed with two layers of sutures. Closure of the rent in the mesentery is made with interrupted catgut sutures.

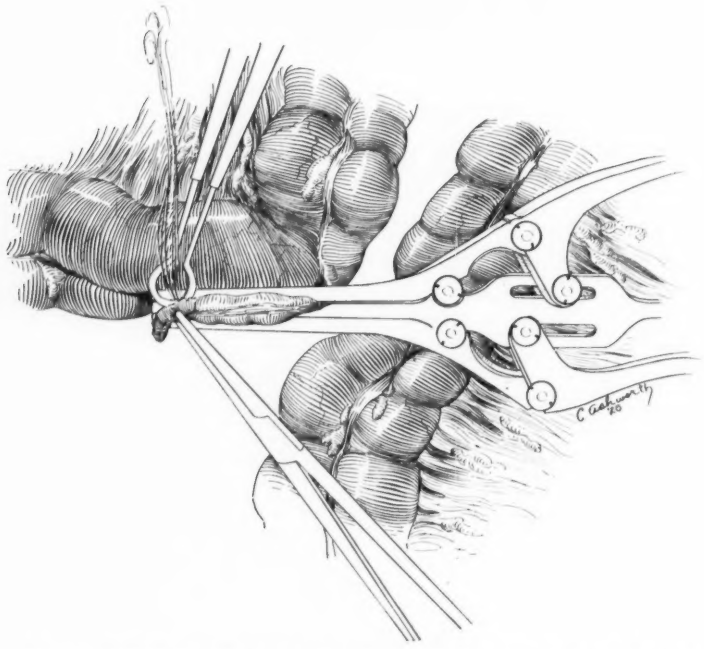

Fig. 18. Preliminary step in colocolostomy, making an opening in one limb of the large bowel by removing a portion of it with cautery.

colon and segment of the sigmoid as a preliminary stage to resection of the splenic flexure or descending colon for malignancy. I have made a colocolostomy between these two segments and in the transverse colon several times over the clamp (Figs. 18 and 19). I have not as yet had an opportunity to employ the clamp in making a lateral anastomosis between two divisions of the small bowel but this is rarely desirable. The accomplishment of lateral anastomosis over the clamp between two mobile segments of the colon is readily carried out in the standard manner. Points are selected which are to be approximated. The clamp is applied first to one segment, an elliptical piece removed above it to open the lumen and a similar maneuver to open the lumen into the other segment. Anastomosis is accomplished by continuous suture, two layers being employed. In resecting the bowel for carcinoma it is well always to use at least one layer of silk or linen because of the uncertainty of the healing powers of the intestine due to desiccation and anæmia. In operating on benign lesions, one rarely needs to employ sutures other than the absorbable type because of the adequate agglutination and repair, but if malignancy has undermined general resistance and impaired the reparative processes, a non-absorbable coapting suture is desirable.

The secondary resection following colocolostomy is carried out after 10 days or 2 weeks in the usual manner, the ends of the bowel being amputated and inverted without opening. If care has been taken to place the sutures only as deep as the submucous coat, the operation may be accomplished with absolute cleanliness.

OBSTRUCTIVE RESECTION

I have found the clamp advantageous in the performance of the so-called obstructve resection which I have come to regard as the operation of choice in many cases of carcinoma of the transverse colon (Fig. 20). Obstructive resection, in reality, employs the satisfactory features of the Mikulicz operation without violating the principles of this procedure as it is usually carried out. Mikulicz operation was originally an exteriorization procedure, applicable to mobile segments of bowel that did not require handling or difficult maneuvers in attempts at mobiliza-

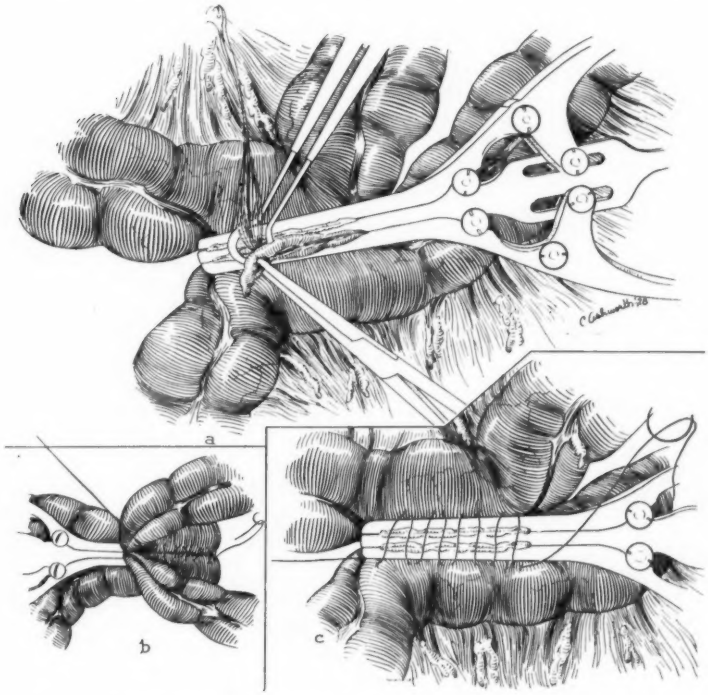

Fig. 19. Colocolostomy. a, Opening in two segments of bowel being made with cautery. b, Posterior suture line. c, Anterior suture line.

tion; it did not, moreover, sacrifice the blood supply to the segment. Failure to observe these two criteria have resulted in the application of the procedure to many cases in which it was totally contra-indicated and the violation of the principles that growths in the colon that are adherent, infected, and permeable may not be handled except with the gravest likelihood of peritoneal contamination. It is applicable to a small scirrhous growth without glandular metastasis which occurs in a mobile segment of the bowel, particularly the sigmoid, and which may be brought outside the abdomen without handling or difficult mobilization and sacrifice of blood supply. In elderly patients, and in patients in whom the risk is great, it is distinctly useful, but for the average large growths, which must be mobilized and handled, and from which contamination is feared by spread of organisms throughout the peritoneal cavity, the substitution of colostomy or some drainage procedure and subsequent resection with anastomosis, has resulted, in my hands at least, in an enormous lowering of the mortality rate and in more satisfactory operative results than when the Mikulicz procedure was used. It is an axiom that the highest mortality attendant on all types of operations on the colon follows operation on the transverse colon where the growths are more easily accessible. The reason for this is clear. In all likelihood, because of the accessibility of the growth, primary resection is most often attempted. Failure results from two main causes: first, inadequate blood supply, and second, peritonitis from direct contamination from the growth at the time of resection.

Since January of this year (1928), I have performed this operation in 5 cases in which the clamp was left on, without failure. The safety of this operation is due, I believe, to adequate preoperative preparation, the use of spinal anæsthesia, and the selection of cases in which the operation may be performed without submitting patients to tedious and difficult procedures of mobilization. In cases of obstruction to the colon, if segregation and proper preparation from

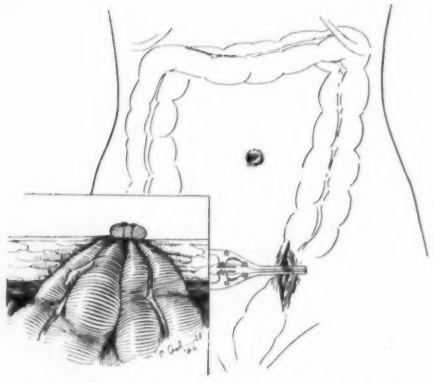

Fig. 20. Obstructive type of resection. Mobilization has been done in a single stage and the bowel removed. The clamp is left on, bringing the end out through the abdominal wall. The layers of the abdominal wall are closed around the bowel. Insert shows appearance of the two ends of the bowel caught in the clamp. In this type of operation the proximal lumen of the bowel may be opened by opening one side of clamp, and the bowel is prevented from retracting by leaving the other side of the clamp closed.

the standpoint of cleansing the bowel and rehabilitation is instituted, the "obstructive" type of operation may be frequently performed (in the transverse segment and the sigmoid) leaving the clamps on 4 days without inconvenience to the patient from the obstruction.

Usually, for 24 hours, and often for 36 hours or longer, following a spinal anæsthetic and resection, the bowel is in a state of paralysis, and there is little or no tendency to the formation of gas and distention. Total abstinence from food and drink by mouth increases the likelihood of the patient's being carried through 4 days without discomfort. Fluids are supplied subcutaneously or intravenously, thus keeping the water balance normal. The thirst of which the patient usually complains is allayed by small sips of water after the first 24 hours, or by sucking a lemon or orange occasionally. The advantage of the clamp in this procedure is that the bowel, which should be brought well out of the abdomen so as to insure adequate blood supply, may be opened on its proximal side, should distention and discomfort demand it, after the first 36 hours. The peritoneum is sutured snugly around the bowel, but sutures are not placed in the wall of the bowel. When the clamp is removed entirely in this type of resection, a spur remains which may be cut out by the application of clamps after about 2 weeks; it remains then merely to close the colostomy opening in the ordinary manner to complete the maneuver. I have found that when the diaphragm is cut through widely following these exteriorization procedures, closure takes place spontaneously in a high percentage of cases.

I am convinced that successful outcome following resection and anastomosis of the large bowel, especially in malignant cases, depends more on adequate pre-operative preparation and rehabilitation measures than on technical procedures, however, highly desirable the latter may be. Disregard for the fact that virulent organisms have a normal habitat in the large bowel, increasing in number and virulence under certain untoward conditions if obstruction is present, perhaps operates more against successful outcome in any type of mechanical procedure than any other one consideration. Consequently, adequate pre-operative preparation of the bowel consisting of drainage procedures after the institution of measures to cleanse the bowel and the routine establishment of a proper diet consisting mostly of carbohydrates and fruit juices which leave little residue, increase markedly the chances of satisfactory recovery. Graded operations under spinal anæsthesia likewise have been highly satisfactory departures from the usual routine. Selection of cases for resection and the judgment to refuse to operate in hopelessly advanced cases will lower the operative mortality in the whole group, and I believe will result in a higher percentage of cures in a given number of cases than the tendency to press the operation in every instance in which the results are uncertain. Increasing the horizon of operability and the institution of more radical measures for resection may be accomplished only by attention to minute details, and I believe it is in this field that an aseptic type of resection, when feasible, while but an incident in the successful operative management of these cases, possesses many advantages.

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ARTHROPLASTY OF THE KNEE[1]

By WILLIS C. CAMPBELL, M.D., F.A.C.S., Memphis, Tennessee

RESTORATION of function by arthroplasty and subsequent treatment is a more intricate problem in the knee than in other joints. This is due to the fact that the knee is the most complex articulation in the body and is dependent for stability upon ligamentous support on all four sides and in the interior of the joint.

In June, 1921, the author's first report was made on arthroplasty of the knee before the American Orthopedic Association, and in January, 1923, a further report was made before the Orthopedic Section of the New York Academy of Medicine. In the first report, including 24 cases, the results were far from satisfactory; in the second, 16 more cases were discussed, which showed a marked increase in percentage of good results. Since the second report, there have been 71 additional arthroplasties of the knee, or a total of 111 cases, and sufficient time has elapsed to determine the actual character, stamina, and durability in a large number of cases in which function has been restored. This, after all, is the real test of the value of the procedure.

Arthroplasty is an operation for the re-establishment of function to an ankylosed joint by the reconstruction, not only of the bones, but of all of the component parts—the muscles, ligaments, tendons, and fasciæ. The operation is only the first step in the program of restoration of function, as careful, systematic after-treatment is essential to success.

Differentiation between the types of ankylosis is of no practical value, although it is important to distinguish the degree of fusion; the prognosis and treatment in fibrous and bony ankylosis is identical. Periarticular restriction of motion is considered only as a complication of either type.

The indications, contra-indications, and limitations of the procedure vary to some extent in the different joints, but in the knee they may be enumerated as follows:

1. Arthroplasty may be considered routinely only when two conditions—acute pyogenic infection and trauma—are the causative agents of ankylosis, or restricted motion. It has been found that the etiology in a very large percentage is an infection by pyogenic organisms such as the streptococcus, staphylococcus, gonococcus, and pneumococcus. These organisms, in primary intra-articular infections, erode and disintegrate the cartilage and superficial bone from within, but do not invade the shaft to an extensive degree. That all evidence of acute infection must have subsided before an operation is performed, is such a well known surgical maxim as hardly to be worthy of mention. Trauma, or the crushing of joint surfaces, tearing of the periosteum, and multiple fractures, are so seldom causative agents of complete ankylosis in the knee as to be almost negligible. However, when incongruity of a joint following comminuted fractures causes pain on movement, arthroplasty is indicated, although a considerable range of motion may be present.

2. Multiple ankylosis, even as the result of a pyogenic infection, obviously renders the problem more difficult and the prognosis less certain as the important after-treatment to restore function may be inhibited by ankylosis of other joints.

3. In monarticular tuberculous joints, operative procedures within the joint are seldom indicated because of the probability of lighting up a latent tuberculous infection. In ankylosis of both knees, the disability is so great that even the risk of a recurrence of tuberculous infection is warranted. In tuberculosis of the knee, solid osseous fusion is rare; however, in those in which osseous fusion has been induced in the early stage of the infection by open operation before extensive destructive changes have occurred, there is greater probability of eradication of the pathological process. It is therefore conceivable that in future years, arthroplasty will be increasingly indicated in cases of this type and the scope of the procedure in the knee will be materially enlarged.

4. Arthroplasty may be employed in low-grade progressive arthritis, such as rheumatoid arthritis and arthritis deformans, but the prognosis is not favorable and at present the procedure in such cases is in an experimental stage.

5. Position is an important factor. Ankylosis in full extension or not over 30-degree flexion, is more favorable to arthroplasty. Flexion contracture of over 80 degrees renders the result more uncertain.

6. Shortening of more than 3 inches as a result of destruction of bone or lack of growth contra-indicates mobilization, as further excision of bone would be required, and the end would not justify the means.

7. Abnormal osseous structure, as demonstrated by the X-ray, may be an important factor

[1] Read before the Southern Surgical Association, December 15, 1927, at Augusta, Georgia.

Fig. 1

Fig. 2

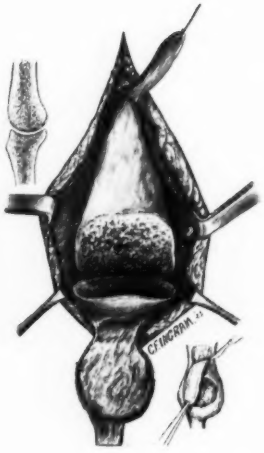

Fig. 3

Fig. 1. Showing the skin incision made medial to the patella for approach to the knee joint.

Fig. 2. The patella has been chiseled from the femur and is retracted laterally with the quadriceps tendon. Note that the quadriceps tendon has not been divided as shown in Figure 3.

Fig. 3. The condyles of the femur and tibia have been remodeled, forming one articulating surface. Note that the quadriceps tendon is shown divided and that the patella is covered by a pedunculated flap from the infrapatellar fat pad. The insert below shows the dissection of the pedunculated flap. The insert above illustrates the contour of the articular surfaces as seen from the lateral aspect.

in determining the prognosis and indications for arthroplasty. The chances of success are decreased when the structure has been transformed for 1 or more inches adjacent to the articular surfaces. Old, dense, eburnated bone, when found for a considerable distance on both sides of the joint in the bones forming the articulation, is not favorable for the reproduction of a movable joint. Such a condition is usually caused by a virulent osteomyelitis, the result thereof being a low-grade bone tissue which bears the same relation to normal bone that fibrous scar tissue bears to normal soft tissue. Healthy, spongy bone should form the articular surfaces of the new joint. Osteoporosis or bone atrophy from disuse should disappear and the structure should return to normal when the position of the limb will permit functional use. As a result of functional adaptation of the osseous structure after many years of complete loss of motion, a medulla or central canal may be formed completely traversing the joint from above downward and surrounded by cortex, which is developed by the transformation of cancellous bone into dense bone. In such cases, sufficient base may not be obtained to form a satisfactory joint, and further, the restoration of function to the atrophic muscles would be difficult.

8. Extensive scar tissue, with adhesion of the skin to the bone, renders the procedure unsuitable unless preceded by plastic measures to invest the joint completely with soft, freely movable tissue. Attempts to close such defects at the time of arthroplasty invariably meet with failure because of the relighting of the infection or sloughing of tissue.

9. The most favorable age is from adolescence to 40 years, although it is not so much a question of years as of the character of the tissues of each patient. Arthroplasty is contra-indicated in children as the epiphyses may be traumatized by operation, and further, it is impossible to secure proper co-operation in the after-treatment.

10. In large, obese individuals, especially women, the musculature and ligamentous structures are always deficient. The ligaments should be conserved and great care should be taken to remove as little bone as possible in making the joint space, as loose, flail joints are likely to occur.

11. In the selection of cases for arthroplasty, the social and financial status of the individual must be taken into consideration. The procedure may be employed in all young adults whose occupation is not hazardous or in those who can be rehabilitated.

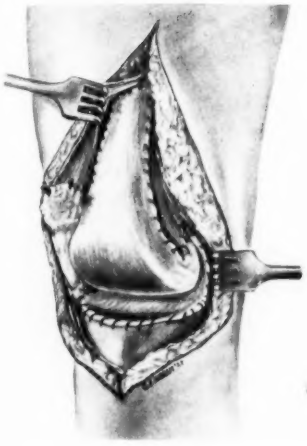

Fig. 4

Fig. 5

Fig. 6

Fig. 4. The new joint has been relined with a free transplant of fascia lata which forms a double layer between tibia and femur, is sutured deep in posterior compartment of joint, and covers anterior surface of femur. A pedunculated flap covers posterior surface of patella.

Fig. 5. The deep and superficial fasciæ are closed by continuous sutures.

Fig. 6. The skin is closed in the routine manner.

TECHNIQUE

In our first cases, we attempted to remodel the joint so that it would conform anatomically with the normal articulation, but we met with a number of failures. We have, therefore, devised a more simple procedure, which will induce function without regard to anatomical detail.

In remodeling the knee joint, no routine technique is applicable to all cases; the procedure must be modified to accommodate the following conditions:

1. Position: (a) extension, or slight flexion; (b) flexion, with and without external rotation and valgus.

2. Distribution of ankylosis: (a) panankylosis, or complete bony fusion of the patella, femur, and tibia, which occurs most frequently; (b) fusion of patella and femur with apparently normal tibiofemoral articulation; (c) tibiofemoral fusion with a freely movable patella.

PANANKYLOSIS IN EXTENSION

An Esmarch bandage and tourniquet are applied on the upper third of the thigh in order to make the field of operation bloodless. The incision is begun from 4 to 6 inches above the knee at the outer border of the quadriceps tendon and extended downward with slight convexity inward, parallel to the medial aspect of this tendon, terminating just below the attachment of the patellar tendon to the tibia. The skin and superficial and deep fasciæ are incised; the incision then passes through the junction of the quadriceps tendon and the vastus internus muscle. Dissection is made to free the quadriceps tendon from the femur and the bony union between the patella and femur is chiseled loose. All ligamentous struc-

Fig. 7. A free transplant of fascia lata is removed from the opposite thigh.

tures are dissected subperiosteally from their attachment to the tibia and femur. If severely contracted, the quadriceps tendon may be lengthened by the Z plastic method; otherwise, it should be retracted outward. The tibiofemoral union is completely severed and until this is accomplished, no attempt is made to flex forcibly, even in fibrous cases, as fractures of the lower extremity of the femur are easily sustained and may constitute a serious complication. The knee is then fully flexed, giving free access to the raw bony surfaces of the tibia and femur. The posterior portions of the condyles of the femur are removed and the intercondylar notch is thus obliterated. The lower extremity of the femur is made convex from above downward and from before backward. Only the absolutely essential amount of bone is removed from the length of the femur, the larger portion of bone being taken from the posterior surface of the condyles. In this way, more space will be formed and the length of the limb will be affected very slightly, if at all. The upper extremity of the tibia is excised as little as possible in order to reach healthy, spongy bone. With a wood carver's chisel, this surface is made slightly concave from before backward, forming a large shallow cavity for articulation with the one condyle of the femur. After excision of the bone, there must be at least a ½-inch joint space when manual traction is made on the tibia. If this cannot be accomplished, more space can often be obtained by dissecting the periosteum posteriorly from the femur and tibia. No attempt is made to reproduce the spine of the tibia or the intercondylar notch of the femur, for there will be no crucial ligaments to prevent lateral displacement. If the articular surfaces are irregular, such lateral displacement may easily occur, bringing the irregular surfaces together with obvious mechanical damage when motion is instituted. The lateral ligaments of the joint must be conserved in order to avoid instability, and care must be taken not to tear, stretch, or sever these ligaments during operation.

The raw surfaces are next approximated, and the alignment of the entire extremity is tested. If varus or valgus is present, more bone is removed from each surface until a perfectly straight hinge is formed. Regardless of the position of the normal limb, special care should be taken not to produce valgus. Future weight-bearing must be direct and in a straight line.

Our attention is next directed to the patella, of which the posterior surface is removed to a very thin layer, or just enough to be consistent with tensile strength. The lateral margins are trimmed for ¼ inch to allow the tendinous fibers to fold backward along the edge of the posterior surface. All surfaces are smoothed with a large rasp; recesses are carefully searched and every particle of loose bone is removed. Just below the patella and on the posterior aspect of the patellar tendon will be found a mass of fat and, at times, remains of synovial membrane. This is severed at the junction with the tibia and dissected from below upward into a flap with a broad pedicle, which is stitched to the margin of the tendinous fibers, thus investing the posterior surface of the patella. This is an important step, for in those cases in which ankylosis recurs, adhesion begins between the patella and femur and is the most difficult problem in the restoration of mobility.

The contour of the new joint has now been completed and prepared for interposition of the membrane. As the former infection may have produced fibrosis in the soft tissues about the operative area of the affected limb, and in order to avoid excessive surgery to the one member, the transplant is best obtained from the opposite thigh.

A long incision is made on the outer aspect of the thigh and a strip of fascia lata about 4 or 5 inches in width and 8 or 10 inches in length is removed. The superficial surface of this membrane is placed next to the bone; its fibers are loosely woven and more readily induce the reestablishment of circulation. To facilitate motion, the smooth, gliding surface is placed within the joint, forming the interior of the articulation. This membrane is placed over the lower 4 or 5 inches of the anterior aspect of the femur, covering the posterior wall of the superior compartment of the joint. It then passes from before backward over the newly formed condyle of the femur and is stitched posteriorly to the posterior capsule of the joint as high as possible; thence, it is brought forward over the new articular surface to the tuberosity of the tibia, terminating on the anterior aspect of the tibia. All free edges are stitched with continuous chromic catgut well over the margins of the joint. Thus, not only is there interposed two layers of fascia lata between the joint surfaces, but one layer is interposed between the quadriceps tendon and the tissues on the anterior surface of the femur. The pedicle flap, which has already been described, interposes an additional layer between the patella and femur. The joint capsule, fascia, and skin are sutured in the routine manner, chromic catgut being used for the deep structures and dermal suture for the skin. Moderate traction is applied and the limb is placed in a Thomas splint.

TECHNIQUE IN PANANKYLOSIS IN FLEXION

When ankylosis occurs in less than 60-degree flexion, the anterior structures are redundant and the quadriceps tendon can always be retracted to the outer side. After removal of sufficient bone, if the posterior capsule is contracted and extension cannot be obtained, stripping of the periosteum from the posterior surface of the femur above and the posterior surface of the tibia below for 1 or 2 inches will usually overcome the contracture and permit the knee to be completely extended, after which the procedure is concluded.

Correction of rotation and valgus or subluxation can easily be made in remodeling the joint.

When ankylosis occurs in flexion of over 80 degrees, it is advisable to do a two-stage operation as follows: by a posterolateral incision, the posterior portions of the condyles of the femur are excised, thus removing about 1 inch of bone at the point of osseous contact to permit greater extension or reduce subluxation, if present. Further extension, if necessary, may be secured by severance of the hamstring tendons. A cast, or fixation apparatus, is applied with the limb extended as fully as possible, but without the slightest tension.

If the necessary degree of correction cannot be attained at the first attempt, the cast is removed at the end of 2 weeks and gradual correction of the flexion deformity is made by means of a special apparatus; otherwise, the cast is worn for 6 weeks. A brace is then applied and walking permitted for about 2 months before proceeding with arthroplasty.

TECHNIQUE IN FUSION OF PATELLA AND FEMUR

In fusion between the patella and femur, with an apparently normal tibiofemoral articulation, the skin incision is made as already described; the quadriceps tendon is dissected free posteriorly; and the union of the patella and femur is severed by a chisel. The interior of the joint is carefully inspected and division is made of any strong fibrous adhesions that may be present. A broad sheet of fascia lata is dissected from the outer aspect of the same thigh and folded inward beneath the quadriceps tendon and the raw surface of the patella, the deep surface of this fold facing the patella and quadriceps. Should extensive scar tissue be present in the affected limb, a free fascial transplant is taken from the opposite thigh.

TECHNIQUE IN TIBIOFEMORAL FUSION WITH A FREELY MOVABLE PATELLA

Tibiofemoral fusion rarely occurs with a freely movable patella. This condition may be a sequela of acute infectious arthritis, but is more often the result of a virulent osteomyelitis extending for a considerable distance into the shafts of the tibia and femur, with direct bone infection across the joint space. The anterior portion of the joint may have been walled off by inflammatory exudate and protected from the process, similar to the phenomenon so frequently seen in the abdominal cavity. If the osteomyelitis has been extensive, the indication for arthroplasty is most questionable.

Should arthroplasty be deemed advisable, the patellar tendon is retracted to the outer aspect, or, if contracted, is lengthened by the Z plastic method. The new joint is then remodeled according to the method already described, although the pedicle flap to the patella is omitted.

This procedure for arthroplasty of the knee is advantageous because: (1) stability is better insured by the broad space of contact between the one condyle of the femur and the one tuberosity of the tibia, as well as by the conservation of the quadriceps tendon and lateral ligamentous structures; (2) loss in length is not appreciable, as the greater amount of bone is removed from the posterior portions of the condyles rather than from the longitudinal dimensions; and (3) the technique is simple and the contour of the bony surfaces is easily remodeled.

Since the last report, the approach to the joint has been radically modified. Formerly, the inverted *U*-incision, with an additional longitudinal incision passing upward at right angles from the center of the *U*, was employed. This has now been entirely discarded, as it has been found that the incision which has already been described is quite ample for exposure of the joint; moreover, when one incision is made at right angle to another, a formation of adhesions and sloughing may occur at the point where the incisions meet. It is also found that the longitudinal incision usually heals better than an extensive transverse incision in an extremity. This is probably due to interference of the blood supply to the part, as an extensive transverse incision severs more blood vessels.

For the past 4 years, we have routinely employed transplants of free fascia lata, as we have found this the most satisfactory material for interposition. In some of our early cases, we applied pedicle flaps and prepared animal membranes, but we have almost entirely abandoned their use. Prepared animal membranes possess the disadvantage of foreign body irritation, invite infection, and may be extruded. Fascia lata transplants from animals, as described by Koontz[1] have

[1] Koontz, Amos K. Ann. Surg., 1926, lxxxiii, 523–536; 1927, lxxxix, 1230–1235.

Fig. 8 *A* (left). End-result shown 2 years after arthroplasty. Active extension of the knee is possible within a normal range.
Fig. 8 *B*. Same case as shown in Figure 8 *A*, showing flexion of the knee to almost 90 degrees.

been employed in one arthroplasty. This tissue is very well borne and gives apparently satisfactory results, although sufficient time has not elapsed to determine its actual value.

In a previous report, the author described hemiarthroplasty, which was employed where only a portion of the joint was fused, as between one condyle and the opposing tuberosity. In such cases, we have since found it more expedient to do a complete arthroplasty; consequently, hemiarthroplasty has been entirely discarded in surgery of the knee.

There have been no serious operative complications or fatalities. Even a severe infection requiring thorough Dakinization does not necessarily prevent an excellent result. However, ankylosis may recur, even if the most careful after-treatment is carried out. In this series of cases, even those which have been classed as failures have been benefited by improved function of the limb and correction of the deformity.

AFTER-TREATMENT

Immediately after operation, moderate traction is applied and the limb is placed in a hinged Thomas knee splint and locked in the extended position; no motion is permitted until the operative wound has entirely healed. This usually requires about 10 days. At the end of that time, a rope is attached to the center of the hoop of steel and above to an overhead frame. A second rope is fastened to the lower extremity of the Thomas splint, passing through a series of pulleys to the head of the bed. By the adjustment of these two ropes, any desired angle may be maintained, and by gravity of the leg under direct control of the patient, active and passive motion may be instituted. The patient soon finds that considerable motion is possible without pain. The after-treatment does not require exceptional fortitude on the part of the patient if function is cultivated gradually.

Great care should be taken to increase motion early, though not too fast. At the end of 30 days, there should be not over 30 degrees of passive motion in the knee, and at the end of 60 days, not more than 40 degrees. If motion is increased too rapidly, the atrophic ligaments may become over-stretched. Furthermore, if osteoporosis—a frequent complication—occurs, the osteoporotic bone will be compressed, thus increasing the joint space and causing irregularity, as well as adding to the danger of producing a loose, flail joint. Active motion should be increased synchronously with passive motion and muscle function should be cultivated gradually until restored to an adequate degree.

Complete extension is essential. Flexion of 60 to 80 degrees gives the best function and a member which can be used for all practical purposes.

If the joint is stable at the end of 6 weeks, the splint is removed and walking is permitted with a Thomas caliper brace with an adjustable joint at the knee for gradual increase of motion. If there is the slightest osteoporosis, a portion of the weight should be borne by a Thomas ring. Full weight-bearing should not be allowed until the structure of the bone is practically normal. Disastrous results may occur as late as 9 months after operation, because of flattening of the articular

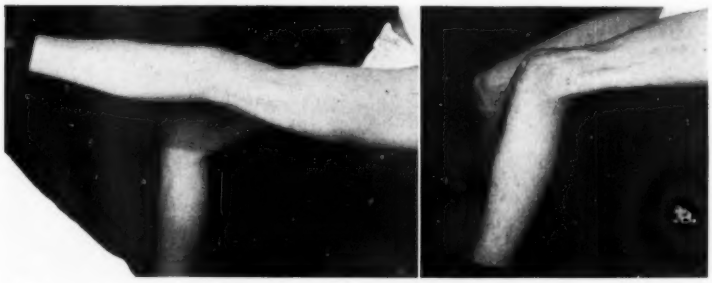

Fig. 9 *A* (left). End-results shown 7 years after arthroplasty for ankylosis between the patella and the femur and reconstruction of the quadriceps from the vasti muscles.

Fig. 9 *B*. Same case as shown in Figure 9 *A*. The knee is flexed while the patient is seated.

surfaces. Weight-bearing without support is not advisable until a fair degree of power has been developed in the quadriceps muscle. Extreme care must be given to the re-education of the extensor groups of muscles; the flexors must also receive due attention. When the patient begins to walk, the knee should be diligently exercised until the maximum power has been restored.

Brisement forcé is unnecessary and, in our opinion, has little if any place in the after-treatment; however, if employed in resistant cases, not more than 10 degrees of increased motion is induced while the patient is under anæsthesia, as otherwise, a severe reaction may impede the progress of the treatment.

Very often after 6 weeks or 2 months, the joint will be quite tender and irritated and ankylosis will appear to be on the verge of recurrence, regardless of all treatment. In such cases, rest for several days, followed by cautiously increased exercise, will usually produce marked improvement. Many cases discharged from the hospital as apparent failures were observed months later and found to have a very excellent result with satisfactory range of motion.

There has been much speculation as to the physiology and histology of an ankylosed knee. Recently, the author had occasion to incise a successful arthroplasty of the knee 1 year after operation. The findings were as follows:

An internal lateral incision was made in the left knee through the former operative scar. The skin and superficial fascia were found to be normal. The capsule and peri-articular structures were much increased in thickness, possibly to about 1 inch. Below the capsule, a definite joint space about one-half the capacity of the normal knee was reached, which extended between the articular surfaces of the tibia and femur and well under the patella and quadriceps tendon. A few adhesions were found between the quadriceps tendon and the posterior wall of the cavity, but these did not interfere in any way with movement. A very small amount of joint fluid was observed; this was less than is found in the normal joint, but was sufficient for lubrication. The articular surfaces were smooth, glistening, and regular, and covered with a dense layer of fibrous tissue resembling in every detail the free transplant of fascia lata which was interposed at the original operation. There was 90 degrees forcible voluntary flexion and full extension.

A section was removed from the lateral aspect of the joint through this fascia, beneath which was found a cartilaginous layer covering the bone. A small portion of bone, with the cartilaginous and superficial fibrous layer, was excised for microscopic analysis and will be reported at a later date.

The present report is based upon the analysis of 111 arthroplasties of the knee in 101 patients, of whom 98 were white and 3 colored. One case had 3 arthroplasties on one knee; 2 had 2 operations on one knee; and 6 had arthroplasties on both knees.

In 1921, a complete analysis of the first 24 cases was made by the author in an article entitled "Arthroplasty of the Knee."[1]

The foci of infection were not so carefully sought in the cases first reported as in those subsequently treated. Only an approximate conclusion can be reached as to the origin of infection, even in the later cases, since most patients were first examined long after all acute symptoms had subsided. As many of the patients did not know the source of infection and others were reticent as to their history, it is not unreasonable to assume that in a large percentage the pathological process was probably gonorrhœal in origin. It is the author's opinion that gonorrhœa is the most frequent cause of a monarticular arthritis, despite the records of this series, and the fact that the knee is more often involved than any other joint. In 57 patients operated upon since the

[1] Am. J. Orthop. Surg., 1921, iii, 430.

Fig. 10 *A* (left). End-result 3½ years after arthroplasty for ankylosis of the knee with flexion deformity. Active extension is possible within a normal range.
Fig. 10 *B*. Same case as that in Figure 10 *A*, showing the knee flexed.

first report, the source of infection is known and is as follows:

Source of Infection	Cases
Tonsils	26
Genito-urinary tract (gonorrhœa)	23
Direct infection (by penetrating stab or gunshot)	6
Teeth	1
Trauma	1
Total	57

Of the 57 patients, 50 gave a history of bloodstream infection from distant foci, and 6 had infection from penetrating wounds, 3 of which were from within, due to compound fractures, and 3 from without, due to gunshot wounds. There is only 1 case of this number in which ankylosis was caused by fractures or crushing of joint surfaces uncomplicated by acute purulent infection. It is therefore concluded that trauma not associated with infection is a negligible factor as the cause of ankylosis.

Since there are so many factors to be considered as influencing the end-results of arthroplasty, a gross compilation of results of 87 cases operated upon since the first report would be greatly misleading. Hence, for analysis, the 87 cases are classified as follows:

1. Ankylosis in young adults as a result of an acute pyogenic infection confined to one knee, the joint being in the position of extension or in not over 40-degree flexion.

2. Ankylosis as a result of acute pyogenic infection in malposition, with flexion of over 80 degrees.

3. Multiple ankylosis or ankylosis of two or more joints as a result of a pyogenic invasion.

4. Ankylosis as a result of virulent osteomyelitis extending through the joint and involving the shafts of all bones comprising the joint or participating therein.

5. Multiple ankylosis as a result of or during the course of progressive arthritis of a low-grade type, as in rheumatoid arthritis or arthritis deformans.

6. Ankylosis in children as a result of pyogenic infection.

Of the 87 cases reported since 1921, 50 conformed to the first group of the classification as ankylosis occurred in one knee in the position of extension or slight flexion. The results of operative treatment were as follows:

Results	Cases
Success	34
Failure	8
Unknown	4
Recent	4
Total	50

It is interesting to observe that the percentage of successful arthroplasties in these cases has increased as more experience has been gained. The results of 18 cases operated upon during the years 1926 and 1927 can be reported. Seventeen of these were successful; only 1 was a failure. The end-results of the entire series show that about 80 per cent were successful, while there was restoration of function in 94 per cent of the 18 operated upon in 1926 and 1927.

There were 8 cases with ankylosis in malposition, or over 80-degree flexion.

Results	Cases
Success	3
Failure	5
Total	8

One of the successful cases had slight lateral instability and requires a brace. In this type, the two-stage operation, as described, is now being employed.

In multiple ankylosis from pyogenic infection, the prognosis is not so favorable, because the re-establishment of function is obviously more difficult when other joints are ankylosed. Of this class, there were 7 cases of ankylosis of the knee, 2 of which were bilateral, totaling 9 arthroplasties.

Results	Cases
Success	4
Fair (30 degrees with valgus)	1
Failure	2
Unknown	2
Total	9

As yet, there is only 1 case of bilateral ankylosis of the knees in which function has been restored in both knees; one knee has 40 degrees of motion, the other, 30 degrees. Sufficient time has not elapsed to state the permanency of the result or degree of motion which may be acquired. In 2 of the cases, no other joint in the lower extremity was involved and there was no difficulty in instituting function. In 1 case with ankylosis of the knee and hip on one side, an excellent result was obtained in both joints. This group belongs to a special class and should form the basis of a separate report.

In 6 cases operated upon, there had been an extensive osteomyelitis passing through the joint, leaving dense scar bone.

Results	Cases
Success	None
Failure	6
Total	6

In all of these, infection of a virulent nature was relighted and mobilization of the joint failed, although function of the limb was improved by correction of malposition. From these results, therefore, it is evident that arthroplasty is contraindicated when ankylosis has been caused by osteomyelitis.

Those cases of ankylosis resulting from a low-grade progressive arthritis involving many joints also deserve separate consideration. In the series, there were 6 cases and 10 arthroplasties belonging to this type.

Results	Cases
Success	1
Improved	2
Failure	7
Total	10

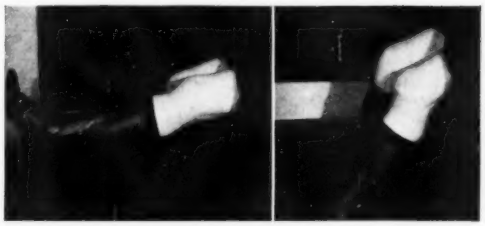

Fig. 11 *A* (left). End-result 8½ years after arthroplasty. Complete active extension of the knee is possible.

Fig. 11 *B*. Same case as that in Figure 11 *A*, showing the range of flexion when the patient is seated.

In the 2 "improved" cases, the patients had fair motion, but no voluntary control; one had a flail joint. However, both patients were well pleased, as they were enabled to walk on crutches and sit more comfortably. In this condition, arthroplasty must still be considered to be in the experimental stage. There have been some fair results in other joints, which makes the procedure worthy of further investigation. Of course, no case is operated upon until all other measures, such as removal of foci of infection, have been completely exhausted.

Arthroplasty of the knee was performed on 4 children.

Results	Cases
Success	1
Failure	3
Total	4

Forty degrees of motion was restored in the successful case, but valgus developed after operation and osteotomy is indicated. This patient, the eldest of the 4, was 14 years of age. From this small number and the results secured in joints other than the knee, the conclusion has been reached that in children arthroplasty is contraindicated not only for the knee, but for all joints.

Of the 111 arthroplasties, infection was relighted or instigated in 19 cases. In 6 of these cases, there had been an extensive osteomyelitis. In 4 cases, the infection was apparently due to irritation of the chromicized pig bladder which had been interposed between the joint surfaces. In 4 cases, the results were excellent, although complicated by a virulent infection; in 2 of these, Dakin tubes were inserted in every direction and irrigation was continued for weeks.

At the present time, there are 43 cases under observation, in which function of the knee, varying from 35 to 120 degrees, has been restored. Only 4 cases have as little as 35 degrees of mo-

tion, and this may increase in time. The average is 90 degrees. The most efficient and durable joint has not over 80 or 90 degrees of flexion, which is sufficient to permit walking without limp and sitting in comfort.

An estimate of the results of arthroplasty of the knee should be expressed in the terms of function and endurance, and not in degrees of motion. As more experience has been gained by observing the complications and important factors in the evolution of the procedure, the operative technique and after-treatment have been refined and the scope of the procedure has been materially increased.

A full report of the entire 43 cases in which function has been successfully restored would be impractical; however, there are 6 cases of special interest, which will be described briefly.

CASE 1. S. W., male, 21 years of age, had an indefinite history of traumatic arthritis of the left knee, with previous operation. Examination revealed a fibrous ankylosis; the roentgenogram showed that there had been a destructive arthritis of an indefinite nature, somewhat suggestive of tuberculosis.

An exploratory operation was carried out to determine whether an arthrodesis or arthroplasty would be the best method of treatment. After the interior of the joint had been reached and the strong fibrous adhesions had been divided, there was no apparent evidence of a tuberculous process; consequently, the routine arthroplasty was performed.

Recovery was uneventful, but drainage continued indefinitely and, after 2 months, several sinuses formed about the knee, also, swelling of a boggy nature increased around the entire joint. It was apparent that an old tuberculous process had been relighted. After about 8 months, the sinuses gradually closed and the swelling receded. At the end of a year, active and passive motion were instituted, with the result that splendid function has been restored.

This case is most interesting on account of the unusual course, the sinuses which persisted over a long period of time, and the excellent result.

CASE 2. H. W., male, 20 years of age, had an indefinite history of traumatic arthritis of the left knee, which had been treated by injections and brace. Examination showed some swelling and tenderness, with increased laxity. The roentgenogram revealed destructive changes in all of the bones of the articulation.

An exploratory operation was carried out and a specimen of the diseased tissue was removed for analysis; this later showed chronic inflammatory tissue. As the nature of the process could not be determined from the gross appearance of the tissue, a fusion operation was carried out without using the patella as a graft, as a future arthroplasty was contemplated. After 3 months, there was solid fusion and recovery was uneventful.

Since the gross appearance of the joint and examination of the tissue revealed no tubercular process, and as the patient wished to obtain a movable knee, the routine arthroplasty was performed 8 months after the first operation. Recovery was uneventful. Function was rapidly restored and at the end of 6 months there was 90-degree motion with only slight laxity; the result was considered excellent.

At the end of 9 months, the patient returned, showing definite laxity and extensive valgus deformity. The X-ray at this time demonstrated extensive destructive changes in the knee, with loss of substance in the external condyle of the femur, due to osteoporosis.

This case illustrates the necessity of careful observation over a long period of time. It is mentioned in order to demonstrate a late and unusual complication, which might have been avoided if such a possibility had been known prior to that time. The cause of this complication was the too rapid increase in motion which was not commensurate with the muscle power.

CASE 3. B. W., male, 19 years of age, had ankylosis of the left knee, with complete osseous fusion between the patella and femur and a total loss of the quadriceps tendon. The tibiofemoral articulation was normal. The etiology was a compound fracture of the femur, with virulent infection of the bone and soft tissues.

The routine arthroplasty was carried out so as to form a new articulation between the patella and femur. In addition, a new quadriceps tendon was constructed from the vasti muscles.

The result was excellent although the quadriceps was of course weaker than normal. Sufficient muscle power was restored to enable the patient to extend the knee fully and to walk without perceptible limp.

This case is of special interest on account of the fact that a functional quadriceps was restored after complete destruction.

CASE 4. M. H. K., female, 19 years of age, had ankylosis of the right knee following a pyogenic infection. Three arthroplasties were carried out at intervals; the first two failed, the third was very successful.

For the past 6 years, the joint has been stable with normal endurance, although the X-ray shows extensive proliferation about the margins of the joint and the patella is fused to the anterior aspect of the upper surface of the tibia, after the manner of the olecranon process in the elbow.

CASE 5. I. P., female, 22 years of age, had a pyogenic infection of the left knee, which caused complete ankylosis. An arthroplasty was performed and recovery was uneventful. Three years later, the patient sustained a comminuted fracture of the left femur into the knee joint.

After 5 years, the X-ray shows extensive proliferative changes in the knee and the patella is fused to the anterior aspect of the tibia. The patient has a durable joint and no inconvenience.

CASE 6. E. K., female, 24 years of age, had a polyarticular pyogenic infection resulting in a solid, bony ankylosis of the right hip and knee, with malformation of both joints. An arthroplasty was carried out in each joint and the result is excellent.

This case is interesting and unusual in that function has been restored to the hip and knee of the same limb.

A STUDY OF ARTERIAL OCCLUSION BY MEANS OF AUTOGENOUS FASCIAL STRIPS

By R. W. McNEALY, M.D., F.A.C.S., and M. E. LICHTENSTEIN, M.D., Chicago
From the Department of Experimental Surgery, Northwestern University

RECENT studies dealing with the surgical occlusion of blood vessels have been conducted along two principle lines. In the first instance there has been a rather considerable amount of work done in developing special clamps or devices for the purpose of producing gradual occlusion of the vessel lumen. In the second instance attention has been directed to the reaction of the vessel and surrounding tissues to the use of such ligature materials as silk, linen, catgut, and especially fascia.

The study of methods of gradual occlusion has had as its incentive the necessity of gradually diminishing the flow of blood through a diseased or injured vessel in order to stimulate the formation of a collateral circulation while still maintaining a supply sufficient to prevent immediate tissue death.

The present study is concerned with a method of gradual occlusion of a blood vessel by transplants of fascia placed about the vessel and anchored in such a way that continuous traction is made in a constricting manner. The use of fascia in vascular occlusion is admittedly in nowise a new procedure, nevertheless, we feel that our results obtained in experimental animals warrant the report of the method which we have used.

The various methods of gradual vascular occlusion may be briefly summarized as follows: snares of silk, metal, or catgut have been placed about vessels so that they can be tightened at intervals. These devices were in most instances unsuccessful because infection traveled along the protruding snare and caused either thrombosis or secondary hæmorrhage from vessel erosion. In other experiments, bands of silver or aluminum were so constructed that they automatically tightened about the vessel or could be tightened by exposing them at subsequent operations. The bulk of these devices and their tendency to irritate the tissues and corrode the vessels rendered their use somewhat hazardous.

In 1912, W. S. Halsted (3) reported his experimental use of strips of aorta, fascia lata, and intestinal wall. The following quotations which have been taken from his original report adequately summarize the results of his series of experiments:

"... in April, 1912, I operated upon two dogs partially occluding the aorta of one of them with a spiral aortic band and the other with a cuff cut from the same vessel. Strips of aorta were employed rather than fascia, for example, because I hoped that the elastic tissue, in case it did not endure, might at least serve its purpose for a time sufficient to cure an aneurism.

"At the end of two months one of the dogs was killed and I was pleased to find that the cuff which had been used in this experiment was apparently organized and had not stretched to any appreciable extent. Above the cuff the aortic pulse was forceful but below the constriction it was very feeble though countable and accompanied by a thrill. The other dog operated upon at the same time and in the same manner, except that a spiral band of aorta instead of a cuff had been employed, died about three weeks after operation. (Death due to pneumonia.) In this instance the aorta had been completely occluded by the spiral aortic strip. The welt like band had not stretched and seemed to be organized. The aorta in being split longitudinally was seen to be greatly wrinkled and almost occluded at the site of the band. . . .

"Since then . . . about 25 similar operations have been performed. We have learned, however, that whereas the spiral bands seem to be perfectly safe there is danger in employing the cuffs. In two instances of twelve or more experiments one of the mattress sutures taken to hold the flaps of the cuffs together cut part way through the cuffs and thus being in contact with the aortic wall wore a minute hole through the vessel through which the animal bled to death. Such an accident can hardly happen with the employment of the spiral strip, for not only is the strain on the stitches very slight when this form of band is used, but even if it were so great that a thread might cut through the spiral at any one point, it could hardly be brought to bear on the aorta in such a way as to wear into its wall."

Since Halsted's report of his experiments, there have appeared from time to time reports of isolated instances of the use of fascial cuffs for occluding vessels when it was desirable to use proximal ligation in the cure of a peripheral aneurism.

Brooks (1), in reporting the use of fascial bands for vessel occlusion, concluded that the ligatures cut through and the bands loosen. For this reason he found objection to their use.

Campbell (2) recently reported 3 cases of peripheral aneurism in which fascial cuffs for proximal ligation were used with apparent success. Little is mentioned in these reports save the clinical features of the cases.

Reid (5) describes a method of occlusion with fascial plugs which are placed upon the blood vessel and held in place by a constricting ligature. Thus no trauma occurs to the intima as the lumen is obliterated by the flattening of the vessel.

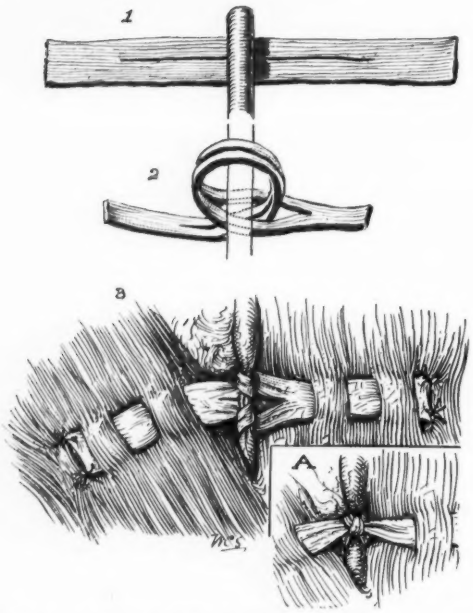

Fig. 1. *1*, Fascial strip ready for application. *2*, The strip is placed under the vessel and one end is threaded through the slit at the opposite end to form a fixed loop. The fascia is drawn through the adjacent muscle by means of artery forceps. Insert shows simple ligation of artery with fascial strip.

In our work little opportunity is offered for the fascia to loosen, and there is no likelihood that the sutures will come in such contact with the vessel wall that erosion might result.

TECHNIQUE

Our method consists in the dissecting of flaps of fascia 5 centimeters long and 1 centimeter wide from any accessible fascial plane. In our experiments on dogs, these strips were taken from the anterior layer of the rectus sheath. This fascial strip was further prepared by its being freed of fat and then slit longitudinally to within about 1 centimeter of each end (Fig. 1). This strip is then placed under the vessel and one end threaded through the slit of the opposite end, thus forming a fixed loop about the vessel. Traction on the ends now serves not only to constrict the vessel but also to angulate it slightly. The next step consists in the forcing of a small pair of artery forceps through adjacent muscles in an interrupted manner and the grasping of the end of the fascia to draw it through the muscle fibers. The tension may now be secured by the fixing of one end of the fascia and gentle traction on the other until the peripheral pulse is diminished as much as desired. This tension may now be preserved by sutures passed through the end of the strip of fascia into the muscle belly.

RESULTS OF INVESTIGATIONS

After intervals varying from 2 weeks to 4 months the condition of the constricted vessels and the fascial transplants was investigated.

The changes in the blood vessels were quite constant. In 5 dogs there was complete occlusion of the femoral artery at the site of the fascial strip. It was impossible to separate the vessel from the fascial strip except by sharp dissection. The vessel showed no apparent destruction of its intima which was longitudinally folded upon itself. In each instance the lumen could be dilated with a small probe. In one case the vessel was markedly constricted but a faint pulse could still be felt distal to the fascial strip. When opened, the vessel lumen presented much the same appearance as in cases of complete occlusion.

The fascial transplants remained fixed in each instance, and there was a firm fibrous union between the connective tissue of the muscle bundles and the fibers of the fascial strips. This characteristic manner of muscle and fascial union which has been described in these experiments bears out the contention of Koontz (4) as to the healing of these structures.

In one of our dogs it was interesting to note that when the fascial strip was first applied and the leg completely relaxed by flexion that the pulse peripheral to the fascial strip could be plainly felt; however, when the leg was completely extended, the pulse was obliterated.

In order to study the comparative value of this method with that of fascial strips used as simple ligatures, we ligated the femoral arteries of 3 dogs with narrow autogenous fascial strips (Fig. 1A). We found that the partial occlusion of the vessels which was established at the time of operation largely disappeared because of the loosening of the fascial strips. We believe that this regular tendency of the strips to loosen may be explained on the basis that there is decidedly less tendency for union of the component parts of a transplant than there is between a transplant and the vascular tissues of adjacent structures as in our method.

SUMMARY

1. This method of fascial occlusion of blood vessels is free from many of the faults found in methods now in use.

2. By regulating the tension on one end of the fascial strip, any desired construction of the vessel may be fairly constantly maintained.

3. No suture material can come in contact with the vessel and cause an erosion of its wall.

4. Fascial strips are not irritating to the surrounding tissue.

5. Fascial strips have no tendency to act as foreign-body irritants to the vessels themselves.

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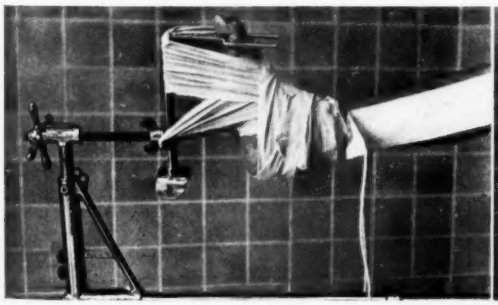
THE TREATMENT OF FRACTURES OF THE NECK OF THE FEMUR BY DOUBLE LEG CASTS IN FIXED TRACTION AND TRIANGLE TRUSS SUPPORT

By JAMES E. M. THOMSON, M.D., F.A.C.S., Lincoln, Nebraska

With the introduction of the so-called Whitman position and wide abduction spica cast in the treatment of fractures of the neck of the femur, the greatest contribution to the treatment of this condition was added to surgery. It is a positive method of maintaining position and alignment of the fragments, provided adequate traction is instituted during the application of the cast through the traction devices of the modern fracture table.

One disadvantage which we encountered in its use was that quite often after several weeks, shortening and loss of position were found to have developed, in spite of the application of a widely abducted spica cast extending from the tips of the toes to the axilla. In addition, there was considerable discomfort at times in the dorsum of the foot, ankle, or knee and especially about the abdomen and chest. This was particularly true of elderly, obese patients. Furthermore, the pelvis on the injured side was usually so severely tipped that considerable permanent disability often occurred.

It was found, however, that by immobilizing both the uninjured leg and the fractured member in wide abduction under traction, only a low pelvic band of plaster was needed to maintain position, so that the upper abdomen and chest could be left free of plaster, thus adding considerably to the comfort of the patient. This also permitted equalized traction on both sides of the pelvis and eliminated the tipping of the pelvis.



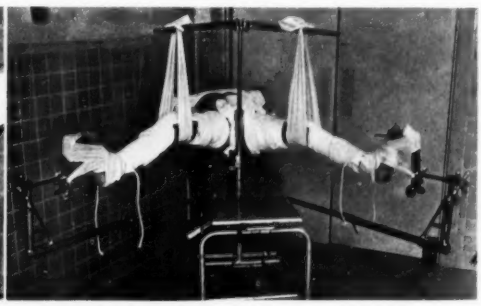


Fig. 1 (left). The foot is bound with muslin bandage to the traction device of the fracture table. Moleskin traction straps with rope ends are applied to either side of the leg, extending from well up the thigh to the ankle.

Fig. 2. The patient lies on the fracture table with both legs widely abducted. The feet are bound to the traction foot pieces of the table. The rope ends of the traction straps are hanging free. Muslin bandage and sheet wadding are placed over the straps. The knees are slightly flexed by means of overhead slings.

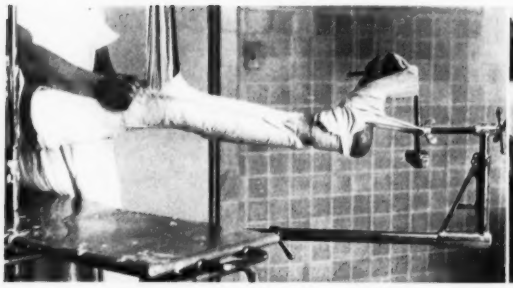


Fig. 3 (left). Application of the leg cast. An assistant pulls on the rope ends of the traction straps which have been turned back against the leg casts. Traction is maintained through the foot of the table. A felt pad is placed against the pelvis.

Fig. 4. Plaster of Paris is bandaged over the rope ends, thus embedding them in the substance of the cast and fixing the traction obtained by the pull on the foot which is bound to the traction foot piece of the table.

To this procedure we then applied the principle of fixed traction, the technique of which Dr. H. W. Orr and I have recently published. The application of this principle to fractures of the neck of the femur is briefly reviewed as follows:

By fixed traction is meant traction which once applied, is so secured by means of the plaster-of-Paris cast that it remains intact during the period that the cast is worn. Its application in this particular instance requires that the patient be placed on a fracture table; that both legs be placed in the extension apparatus by binding the feet firmly to the foot pieces of the table, and be abducted to the degree necessary to bring about apposition of the parts. Traction is then applied equally to the uninjured as well as the injured leg thereby bringing the pelvis down in correct position against the pelvic rest of the table. When full length and proper position are attained, long moleskin traction straps which have rope ends and extend well up on the thighs, are applied to either side of both legs and held in position by muslin and sheet-wadding bandages. The knees are flexed slightly by means of overhead retaining slings and a plaster-of-Paris, double spica cast is applied from the lower pelvis down to the ankles. After the plaster has set, the rope ends of the traction straps are turned back against the sides of the leg casts. While forceful pull is made on the ropes, plaster-of-Paris, sufficient to imbed them in the cast, is applied. The traction is kept up during the procedure through the foot pieces to which the feet are bound. Therefore, when the bandages are cut from the foot, the fixed traction straps will not permit the leg to slip back up into the cast.

Two boards, one below the knees and behind the calves of the legs, and the other above the knees and over the quadriceps region, are imbedded in the plaster cast. Sheet wadding is applied to the feet and they are put up in plaster in the right angle position if one is not certain that

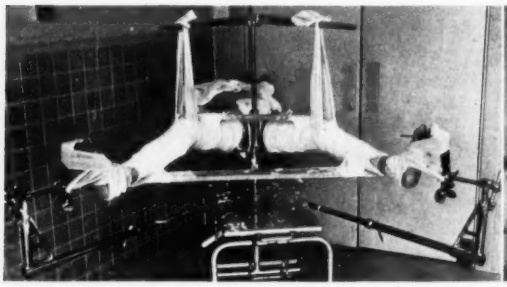


Fig. 5 (left). Showing the two cross boards which are imbedded in the casts. One is placed below the knees and behind the calves of the legs; the other is above the knees and over the quadriceps group. Traction is maintained by means of the traction straps which are imbedded in the casts.

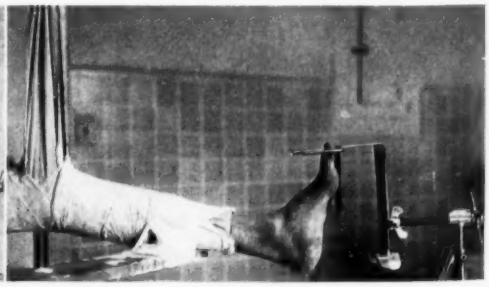


Fig. 6. The muslin bandage has been removed from the foot which rests where it was bound against the foot piece of the table. The traction straps have been embedded in the cast, thus fixing the traction. The cross bars prevent the foot from slipping up into the cast.

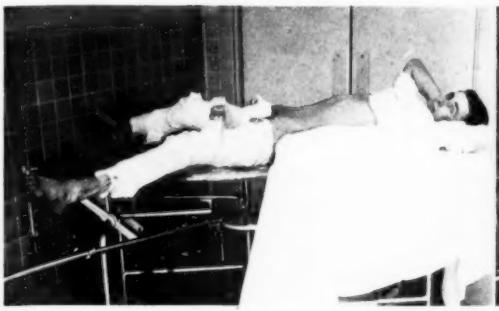


Fig. 7 (left). Showing the completed casts with cross bars in place.

Fig. 8. Tipping the casts also tips the pelvis. The triangle-truss support supplied by the cross bars insures the relative movement of all the component parts when one part is moved.

proper exercise will be given to the feet to prevent their falling into an equinus deformity. However, if the patient can afford adequate nursing care, he derives great satisfaction from having his feet left out of the cast. Daily massage can be given and the patient can be encouraged in the use of the muscles of the leg and foot.

When the patient is moved to a bed, the springs should be stiffened by cross boards under the mattress, the foot of the bed, should be elevated 8 or 10 inches and just sufficient weight should be tied to the lower cross board and placed over the end of the bed to accommodate the pull of the body against the cast. The amount varies, of course, with the weight of the patient. In this position the patient can be turned on his face daily or propped up a little.

Even with this short cast about the pelvis, many elderly patients with pendulous abdomens have objected strenuously to the restraint of the plaster about this region and have said that if they could only be propped up some of the time in bed and not have a tight band across their "bowels" they would be happier. Therefore, after a week or so, the anterior or abdominal portion of the pelvic part of the cast was removed letting the posterior part hold the legs in position. The patient was propped up with pillows or back rest, care being taken that strenuous traction on the cross bars of the cast was kept up and the foot of the bed kept elevated. Roentgenograms have shown that no ill effects result from this modification of treatment.

Fig. 9. This patient had been in casts for 8 weeks. From the time the casts were applied, she had been able to sit propped up with back rests as often as she wished. During her stay at the hospital, she did a considerable amount of reading and writing. The foot of the bed is elevated. Traction is applied to the lower cross bar over the foot of the bed.

The success of this procedure led to the adoption in practically every case of the following technique: Two leg casts are applied in a widely abducted position, both legs having fixed traction applied by the use of moleskin traction straps imbedded in the cast. One cross bar is placed above and one below the knees, thereby equalizing the pull of one leg against the other and that of both legs against the bony pelvis.

The essential points in the application of the leg casts are exactly similar to those described in regard to the double spica. Considerable care should be taken to make sure that the leg casts come well up against the pubes and high up about the trochanteric prominences. The casts must fit well. There should be ample padding in the region of the pubes, the trochanters, and the knees. For this purpose, a light-weight felt is preferable, but care should be taken that the padding is not too heavy.

The writer has endeavored to illustrate the principles involved by a series of lines forming an inverted *Y* (Fig. 10). The angle at the junction of the *Y* represents the pelvic girdle; the upright line, the trunk of the body. The two forks represent the lower extremities. A break appears in

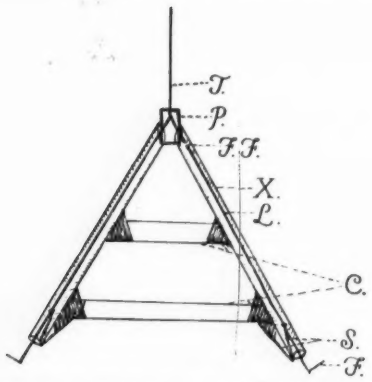


Fig. 10. The double leg casts with triangle-truss fixation for fracture of the neck of the femur resemble the branches of an inverted Y. The upright of the Y represents the trunk, *T*; and the rectangle, the pelvic girdle, *P*. The cylinders *X* represent the leg casts extending from the pelvis to the ankles. The traction straps, *S*, are brought over the ends of the casts and imbedded therein so as to maintain the traction. The cross bars *C* form the triangle trusses and prevent the loss of position of the parts. *L*, Line representing lower extremity. *F*, Foot; *F*, *F*, fracture of neck of femur.

one of these lines just below the pelvic angle. Along the course of these lines a cord is attached and about them two cylinders are placed, the upper end of each in contact with the pelvic angle, the lower coming well down to the ankle region. Separating these cylinders are two cross bars welded into the cylinders, one up near the pelvic girdle and the other down toward the ankle. The traction cords are attached to the extremity lines and are brought down over the lower end of the cylinder and turned back tightly against it and then tied to the lower cross bars. At the unction of each one of these cross bars with the cylinder, a rigid triangle truss is formed. The cords attached to the extremity lines and to the low cross bars hold the cylinder up in position against the pelvic angle and stabilize the extremity within the cylinder so that every turn which the body makes involves a rotary movement of every other part of the frame work from the pelvic girdle down so that it is impossible to change the position of the broken extremity. Thus, one extremity is splinted against the other and the traction on each is firmly fixed.

Here the engineering structional principle of a series of triangle trusses is applied through the cross bars and pelvis. The traction straps, in addition to holding the traction, stabilize the lower extremity in the casts. Such procedure, when applied to the human body, has an even greater stabilization than shown in the illustration, in that, about the fractured neck of the femur are the heavy muscles of the hip joint which aid greatly in the stabilizing of the fragments.

In addition to this procedure, for the past year or so, we have uniformly impacted, with gratifying results, every fracture of the neck after the method described by Dr. Fred J. Cotton. More recently the writer has used a concave block fitting over the trochanteric prominence against which the blows of the mallet may be more accurately aimed. The impaction adds much to the security of these cases and seems to help bring about their successful termination. Elderly, fleshy patients tolerate this method of fixation better than any other as it enables them to have far more freedom than can be allowed if the trunk is covered with a cast or than can be had by Buck's extension, Thomas splints, or other traction apparatus. The method involves the use of a traction table which is now a part of the operating room equipment of every first class hospital.

At first, I used this method rather dubiously but constant checking by X-ray examination demonstrated the reliability of the procedure so that now I allow these patients almost unlimited freedom in bed, provided traction is kept up on the lower cross bar over the end of the bed to take care of any unusual jerks or sudden change in position that may occur during the first week or so of treatment. Very often, in spite of strict orders, I have found patients sitting bolt upright without even a back rest, shaving or combing their hair or lying on one side half way out of bed. I have often suspected a loss of position, but X-ray examination has always shown the fragments to be in correct alignment.

After 8 or 10 weeks the casts are removed and a long well fitting ring caliper splint is applied. This is worn for a month. The patient is allowed to use a wheel chair. During this time massage and active and passive motion are encouraged daily. At the end of 12 weeks the patient is allowed to walk with crutches. The weigh on the fractured leg is carried through the ring against the ischium. If the X-ray examination is satisfactory, after 6 months the patient may walk with a cane and crutch until at the end of 9 months to a year, all apparatus and support may be discarded.

A sufficient number of cases have now been treated successfully by triangle-truss supported leg casts to justify a preliminary report of the technique. I have found that this method adds much to the comfort and well being of my patients and so far the procedure seems to be thoroughly satisfactory.

A NEW PROCEDURE IN THE DIAGNOSIS OF URETERAL CALCULI[1]

By RALPH L. DOURMASHKIN, M.D., New York

SINCE the advent of X-ray and cystoscopic methods of diagnosis of ureteral stones, the correct interpretation of X-ray shadows lying in the course of the ureteral tract has presented many difficulties. The extraneous shadows lying side by side with the ureter may frequently exhibit typical signs of a ureteral calculus, so as to confuse the most experienced observer. An error is especially possible when the symptoms point to a lesion in the urinary tract on the side on which the shadow was noted.

Twenty-six years ago, Kolischer and Schmidt (3) suggested the use of a shadowgraph catheter in order to determine the relationship which may exist between the lumen of the ureter and suspicious shadows. This simple procedure remains up to this date the most reliable method by means of which most of the shadows of extra-ureteral origin may be so determined by finding them at some distance from the course of the opaque catheter. A possible error which probably was not pointed out before may be due to the failure

Fig. 1. Extra-ureteral shadow having all the typical marks of a ureteral calculus. The patient was a young man giving a history of severe attacks of renal colic on the same side. The shadow resembled a stone so closely that the patient was advised on the strength of X-ray findings to have an operation. The extra-ureteral origin of the shadow is, of course, self-evident (double ureter being excluded by cystoscopic examination); however, if this shadow had been in closer proximity to the ureter, an error in diagnosis might very easily have been made. Note the dilatation of the ureter which is most probably the result of a stricture below.

Fig. 2. A pyelo-ureterogram illustrating the reason for the failure to elicit scratch marks on wax bulbs passed into ureter containing a stone. The upper arrow indicates the filling defect produced by a small uric-acid stone floating freely in the dilated portion of the ureter. On the plain X-ray film the position of the filling defect was marked by a faint shadow separated from course of the opaque catheter by ½ centimeter. The lower arrow indicates the filling defect produced by the wax tip of a shadowgraph catheter which was drawn down while the opaque solution was injected. This case demonstrates how a wax bulb may pass by the stone without effecting an actual contact with it.

[1] Read before the Section of Genito-Urinary Surgery, New York Academy of Medicine, January 18, 1928.

Fig. 3. A rubber bag inflated with opaque solution and the shadow of an impacted stone (upper arrow) placed immediately above it. Note that the tip of the catheter (lower arrow) is within the bag shadow, 12 millimeters short of its distal end showing that the bag expanded in longitudinal direction at least that distance to reach stone.

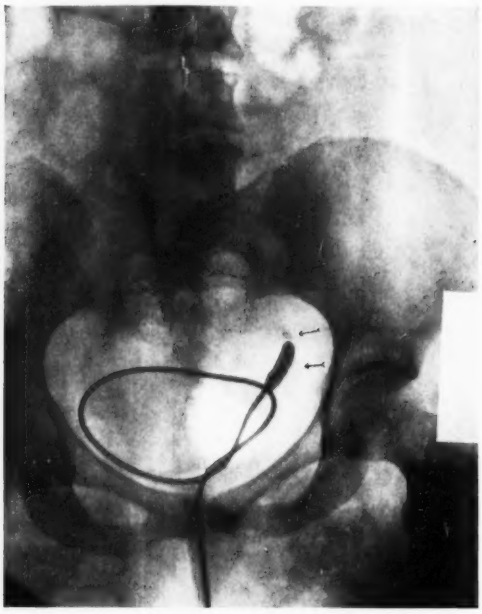


Fig. 4. In this case the stone was pushed up for 3.5 centimeters and its shadow is seen immediately above the bagogram.

Fig. 5. A stone shadow (arrow) in close proximity with that of inflated rubber bag. In this case the bag was deliberately placed alongside the stone. Note that the indentation on the side of the bag is in contact with the calculus.

on the part of the cystoscopist to recognize a double ureter on the affected side. When a shadowgraph catheter in such a case is passed into the ureter not containing the stone, the finding of the shadow (produced by a stone in the other ureter) at some distance from the course of the opaque catheter may lead one to an erroneous conclusion. That the condition is not so very rare may be surmised from the fact that the author found 2 such anomalies in a series of 355 cases of stone in the ureter (1). Another error may be due to a stone floating in the dilated portion of ureter in which case its shadow may be seen to be separated from the course of the opaque catheter (Fig. 2).

The use of the opaque catheter, however, is of no diagnostic value when the shadow in question is found in close proximity to the catheter, as a similar picture may be produced by an extraneous shadow incidentally in juxtaposition with the ureter. Ordinarily in the presence of impaction we have sufficient cystoscopic evidence pointing to calculous obstruction. In such cases, the diagnosis based on cystoscopic findings and corroborated by an X-ray showing the opaque catheter either just below or in close contact with the shadow in question is easy. It is in non-impacted cases in which the cystoscope very frequently fails to show any evidence of trouble, that correct interpretation of X-ray shadows is essential. The use of the wax-tip catheters, at least in our experience, has been entirely unreliable in that it too

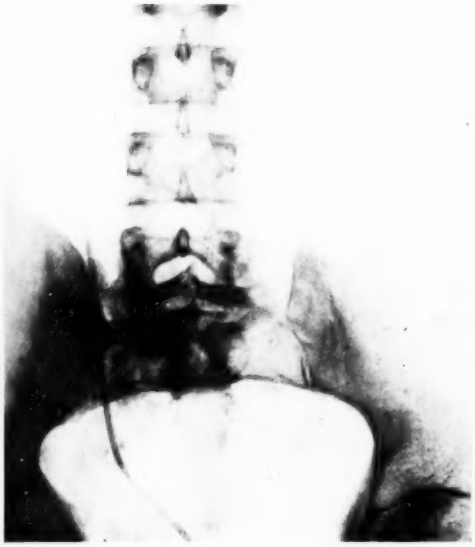


Fig. 6. Case 1. A shadow (arrow) placed in close proximity with an opaque catheter, 7 centimeters above the bladder. The patient was a young man, whom I saw in September, 1926, and who gave a history of repeated attacks of renal colic on the right side. Cystoscopy revealed diminished renal function and moderate amount of retention on the same side. A slight obstruction was encountered at 7 centimeters with a No. 8 Charriere wax-tip catheter, which was negative for a scratch mark. A diagnosis of ureteral calculus was made.

Fig. 7. Case 1. Three months later. The right ureter was gradually dilated until 3 catheters (Nos. 5, 6, and 7 Charriere) could be introduced easily. Note that the shadow (arrow) is still in the same place. The patient no longer complained of attacks of renal colic.

frequently fails to elicit scratch marks. It is, indeed, very surprising how a wax-tip catheter may slip by a stone, or push its way up and yet escape without the slightest indication of any scratch mark. This may be due in a great measure to the comparative smoothness of movable stones, to a film of slimy mucus covering the calculus, or to the passing of the wax bulb into a dilated ureter without effecting an actual contact with the stone.

The double exposure from different angles, a method used by Kretschmer (4) since 1918, has been of great value in determining the status of suspicious shadows in some cases. It is, however, not always successful as the questionable shadow may remain in the ureteral line on both exposures (Fig. 11). Furthermore, the shadows frequently become so blurred, that the correct interpretation of the roentgenogram is impossible. Faint shadows are often not duplicated and are difficult of recognition in pictures taken of stout patients.

Bransford Lewis (5) in 1922 described an ingenious method whereby true stone shadows could be differentiated from those cast by phleboliths or calcified glands. By using his rigid dilator, he caused the ureter to be straightened out thus separating it from an extraneous shadow, which was previously noted to be in close contact with a flexible catheter. This method, however, entails the passage of a rigid instrument beyond the level of a shadow in question, which may not always be done and is of doubtful value higher up, where the course of the ureter is fairly straight.

Recently Ziegler (8) suggested the use of a double exposure roentgenogram on an empty and distended bladder. If the shadow is that of a stone, it will be doubled because of the elevation of the lower ureteral segments by the distended bladder, while the shadows of extra-ureteral origin will remain single. Joseph, in his recent visit to the United States, showed some interesting films illustrating this method. Such a procedure, however, is of value only in cases in which the shadow is seen in the region of the juxtavesical portion of the ureter. Furthermore, the

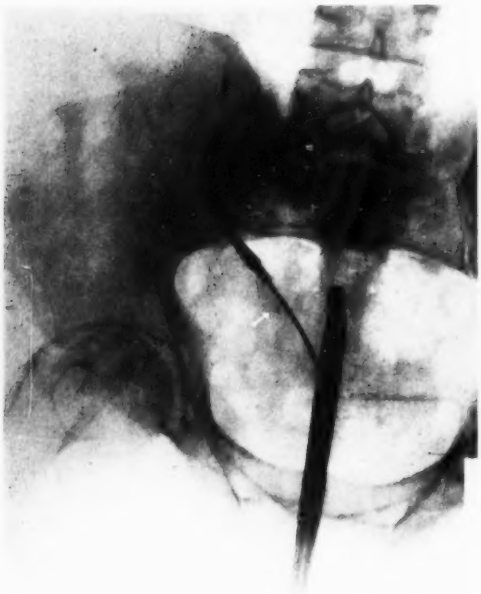


Fig. 8. Case 1. Four months later. The shadow (arrow) is still seen in the same place. No. 14 F. tunnelled bougie is seen to pass it by. The catheter attached to the bougie was non-opaque, save for a silver lining, which explains the narrow space separating it from the shadow in question.

Fig. 9. Case 1. Five months later. The patient reported complete disappearance of all symptoms, but plain X-ray films continued to show the shadow in the same place. A rubber bag was inserted below the shadow in question and inflated with opaque solution. Note the complete disappearance of the former shadow and an hourglass constriction in the bagogram, typical of a stricture. The shadow reappeared on a subsequent X-ray film after the rubber bag was deflated and removed. The patient evidently had no stone. Relief of symptoms was undoubtedly due to the dilatation of the stricture.

picture is very often blurred, especially in stout patients, and in several instances of positive ureteral stone shadow, I have failed to produce its reduplication.

The stereoscopic X-ray examination, while of great value in certain types of cases, will, quoting such an authority as I. Seth Hirsch, often fail to show the true relationship of X-ray shadows lying alongside of the ureteral tract to the lumen of the ureter. The stereoscopic apparatus has not as yet become part and parcel of the urological equipment, and in its absence one must resort to other methods of diagnosis.

The injection of opaque solution into the ureter is sometimes of no value because, unless the stone shadow is faint, or the solution is highly concentrated, it produces no contrast between the shadow cast by the calculus and that produced by the opaque solution, with the exception of the non-opaque uric acid stones which may be beautifully demonstrated by a filling defect. Stevens (7) was the first to describe this procedure in 1917, and in the author's experience it has proved of immense value in clearing up some doubtful cases.

Recently the author has resorted to a new procedure which it is believed offers an accurate solution to the problem. This method depends upon the property of the rubber-bag catheter, when introduced into the ureter and inflated, to expand not only laterally but in a longitudinal direction as well, as has been shown by the author experimentally on cadavers and clinically in a large series of cases (2). The type of the rubber bag used is that which is attached to the catheter only at the proximal end (Fig. 14). The bag when introduced to a point even several centimeters below the calculus will continue to expand until the stone is reached (Figs. 3 and 4). If the stone is impacted, the longitudinal expansion will stop short (Fig. 3). If the stone is movable, it will, as a rule, be pushed up by the inflated bag sometimes for a distance of 4 or 5 centimeters (Fig. 4). This was demonstrated clinically in numerous instances. In *all cases* the resulting bagogram will show the stone *above* the inflated bag unless the bag was distended when placed deliberately alongside of the stone, in which case,

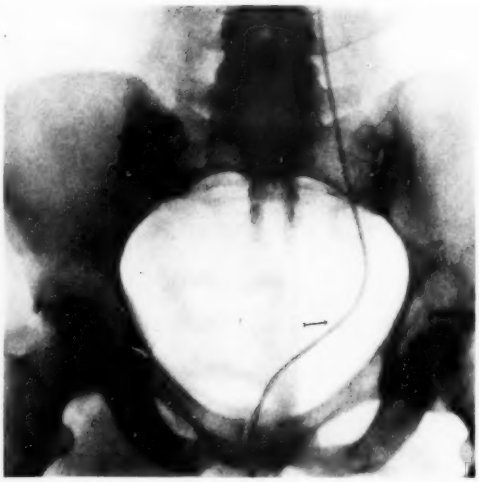


Fig. 10. Case 2. A shadow (arrow) in close contact with opaque catheter in left ureter in a woman giving a history of repeated attacks of left renal colic. Cystoscopy revealed left-sided hydronephrosis, decidedly diminished renal function, and low grade colon bacillus infection. There was no obstruction to a No. 9 Charriere waxed-tip catheter which was negative for scratch marks.

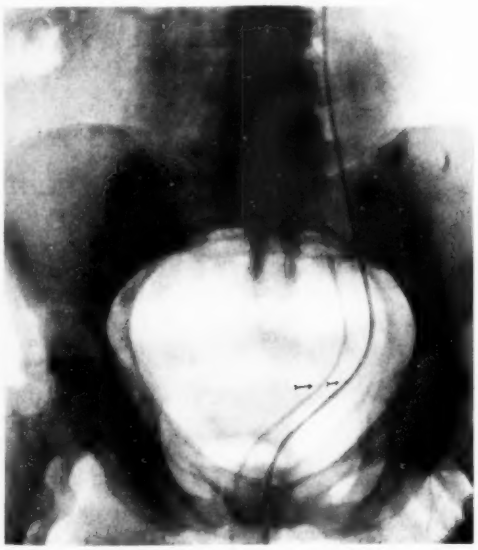


Fig. 11. Same as Case 2. A double-exposure roentgenogram revealing the shadow in the same relation to the opaque catheter on both exposures, causing the erroneous impression that the shadow in question is that of a stone.

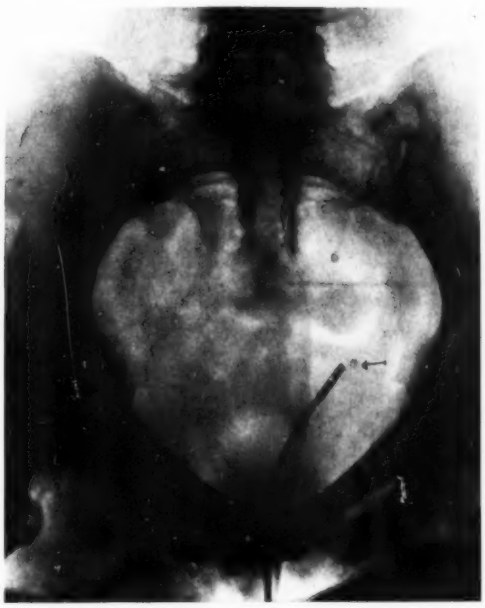


Fig. 12. Same as Case 2. A rubber bag was introduced to a point below the shadow (arrow) and roentgenogram taken before inflation.

definite indentation will be produced on the side of the bag in contact with the calculus (Fig. 5).

A rubber bag introduced below the shadow in question, previously noted alongside of an ordinary opaque catheter, will produce, when inflated with an opaque solution, a shadow which will be superimposed upon, and cause the complete disappearance of, any shadow of extra-ureteral origin, while that of a true stone will be seen above the bagogram. As far as I know, this method permits of no source of error except in those rare cases in which the stone is lodged in a ureteral diverticulum as in the case of McFarland (6). It may be argued on a theoretical basis that a stone in the ureter may be lodged behind or in front of an inflated bag and its shadow be "swallowed" by that of a rubber bag. Practically this is impossible because in our technique the bag is always introduced to a point *below* (Fig. 12) the stone and its position verified by X-ray before inflation. When a bag is inflated within the ureter, longitudinal expansion takes place only after the ureteral wall is stretched laterally to a point within a certain degree of distensibility. This again has been shown experimentally on human cadavers and ureters of oxen. Before the bag has reached the stone, the lumen of the ureter is filled up so completely with the inflated bag that any

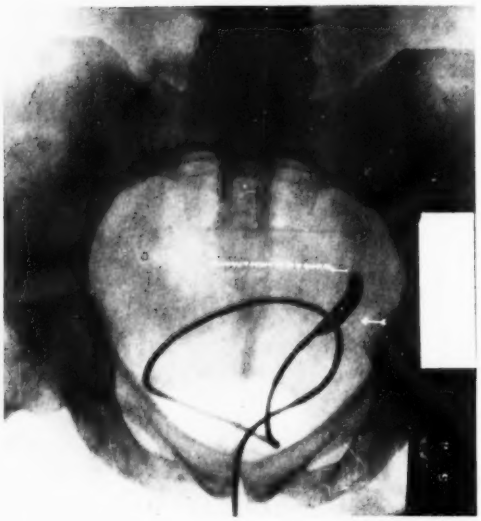


Fig. 13. Same as Case 2. The rubber bag inflated with opaque solution. The lower arrow indicates the position of the tip of the catheter within the bag, which is seen to expand longitudinally for fully 3 centimeters. Note the disappearance of the shadow in question, the same being "swallowed" by that of inflated rubber bag, thus showing its extra-ureteral origin. Had this been a true stone shadow, it would have been noted above the rubber bag.

possibility of the dropping of the stone behind, in front, or on the side of it, is excluded. Occasionally, a fragment of the extraneous shadow may still be seen alongside the bagogram because of the failure of the ureter to expand sufficiently in a lateral direction to cover it. The extra-ureteral nature of such a shadow may, of course, be readily understood.

Fig. 14. An inflating device used in this work, in which the bag is tied to the catheter at the proximal end only allowing free distention of the distal portion.

Fig. 15. A rubber-bag catheter with an olive tip. The bag is tied at both ends and permits a lateral distention only and for this reason could not be used for diagnostic purposes.

To avoid repetition the case reports are condensed into legends accompanying the illustrations which, the writer believes, will cover all the points which have been suggested.

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BILATERAL DOUBLE PELVIS AND URETER WITH ANOMALOUS OPENING OF THE SUPERIOR LEFT URETER INTO THE URETHRA

Congenital Ureteral Incontinence

By ROBERTO ALESSANDRI, M.D., F.A.C.S. (Hon.), F.R.C.S. (Eng., Hon.), Rome, Italy
Professor of Clinical Surgery in the University of Rome

AMONG ureteral abnormalities, one, although not of very frequent occurrence, is more important than duplication or bifurcation. This condition is easily recognized because of its peculiarities. By this I mean the anomalous opening of one ureter out of the bladder sphincter and the resultant continuous dribbling of urine. We have called this special type of incontinence "congenital ureteral incontinence." Its typical clinical feature is that although the bladder can be normally voided the patient complains that since birth he has continually lost urine.

These cases are not frequent, or perhaps it would be more correct to say that such cases have not been frequently recognized at examination. In many of the cases a diagnosis has been made of true vesical incontinence. I must add, however, that not every ureter which discharges urine outside of the bladder gives rise to the clinical picture already mentioned.

According to Kelly and Burnam, ureters have also been observed which end in a blind sac or open into the bowel (rectum and cloaca, intestine, urachus, or amniotic cavity). However, I wish to discuss only the cases of anomalous ureters which discharge in the male into the posterior urethra, seminal vesicle, ejaculatory duct, ductus deferens, and prostatic vesicle; and in the female into the urethra, vagina, vulva, Gaertner's canal, uterus, and fallopian tubes.

I shall only mention the anomalous openings into the bladder because these never give rise to involuntary loss of urine. There is also lack of incontinence in the already mentioned abnormalities in the male because the openings are generally situated above the colliculus so that the external sphincter is able to maintain bladder continence. In the female, incontinence is not present if the anomalous ureter discharges into the uterus, tubes, or Gaertner's duct. However, it is typical when the opening is in the vulva, urethra, or vagina. Therefore, I would state that only when the ureter discharges into the urethra or vagina does the clinical picture of incontinence exist. The patient, since birth, has had a continuous involuntary loss of urine, while at the same time, the bladder function has been quite normal. These two apparently contradictory conditions seem to indicate the presence of an anomalous ureteral opening. It will not usually be difficult to discover such an opening if a careful examination is made. The discharge of urine, often occurring with ureteric rhythm, is our principal guide.

The real importance of such an abnormality lies in the great inconvenience which it causes. When incontinence is not present, the abnormality is not recognizable, and if inflammatory complications do not supervene, it has no clinical importance. The majority of these abnormal cases remain unnoticed; as is also true in cases of bifurcation or double ureters when no pathological condition exists. Infections and calculus complications occur frequently in these anomalous urinary systems because the congenital malformation leads to stagnation of urine.

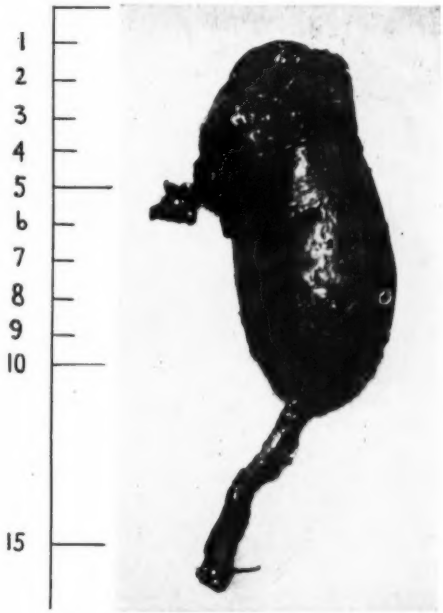

Fig. 1. Superior half of kidney excised.

Fig. 2. Right pyelogram.

Fig. 3. Left pyelogram.

In the case which I wish to present, there was an anomalous orifice in the urethra of one of the left ureters (the upper one, as it always happens) and also a duplication of the right ureter and a bilateral double pelvis. Such an anomaly is exceedingly rare, and I think the case is well worth reporting because, as far as I know, radical operation (heminephrectomy) has never before been performed in such a case.

A total of 110 cases of ectopic ureteral openings have been reported in the literature with 50 cases of bilateral ureteral duplication. Kilbane, in a very careful paper, classifies the abnormality in 7 different types: (1) one ureter with an ectopic orifice; (2) duplex ureter of one side with an ectopic opening of the supernumerary one; (3) bilateral ureteral duplication with ectopic openings; (4) duplication of one side with double kidney and pelvis, and with an ectopic opening of the supernumerary ureter; (5) bilateral double ureter and pelvis with one ectopic opening; (6) bilateral double ureter and pelvis with bilateral ectopic openings; and (7) single, normal ureters, each discharging out of the bladder.

The second type is most common. M. Ascoli, who has fully reported my case, has added other cases to those gathered by Kilbane, i. e., 1 to the 24 of the first type and 9 to the 55 of the second. To the 64 cases of the second type, I must now add two other cases published more recently by Gaudiani and Puccinelli. Kilbane reports only 14 cases of the fifth type. Mine would be the fifteenth case. Twelve autopsy reports are given and 1 has been observed by Madelung in a girl of 14 years, who had a supernumerary left ureter opening into the vagina; no operation was performed.

Only one case, that of Alsberg, has been operated upon. This patient was an 18 year old girl with a supernumerary right ureter discharging into the anterior wall of the vagina. Alsberg thought that there was a vesical fistulous opening and tried to extirpate the sinus which went in the

direction of the right parametrium. The patient died from pyæmia; at autopsy it was found that the sinus went to the right pelvis. This case must be considered as having a supernumerary ureter; even at the left there was ureteral duplication.

Because of the rarity of my case and its surgical interest, I will report its clinical history.

Miss Aurelia T., 14 years of age, entered the hospital complaining of a continuous incontinence of urine which has been present day and night since birth. The bladder function, however, is normal and 4 to 6 times a day the patient voluntarily voids the bladder. She does not have this impulse at night. Family antecedents and personal history are not significant.

Examination. The patient's general condition is very good and she looks quite healthy. No congenital malformations are to be noted. The thorax and abdomen are normal. The skin of the labia majora and the internal surface of the thighs on their superior third have undergone a process of dermatitis. At regular intervals, almost with ureteric rhythm, the urethral meatus opens and a drop of urine comes out. Vesical catheterizing was easy; 100 cubic centimeters of urine was obtained.

Cystoscopy. The bladder is normal and when it is filled with 250 cubic centimeters of water, the patient feels an intense stimulus to void, but if told to hold the urine she easily obeys. On the right side, two ureteric orifices are to be seen, one is in the normal site, the other is lower and more medially situated near the internal urethral opening. On the left side, only one ureter is in the normal site. All three openings look quite normal.

Urethroscopy. On the posterior urethral wall, very near to the external meatus, an orifice looking like a ureteral opening is seen. It looks a little smaller, its lips are reddish and move rhythmically. Indigocarmine given intravenously returns after 3 minutes from the endovesical openings. No elimination from the extravesical orifice is noted. Two No. 6 French catheters pass freely into both right pelves. A pyelogram shows two normal pelves. The ureters cross each other according to the Weigert-Meyer law (Fig. 2).

A catheter is easily passed into the left vesical ureter up to the pelvis. From the extravesical opening it is impossible to push it more than 20 centimeters. A pyelogram shows that on this side also there are two pelves and that the ureters cross each other. The inferior pelvis corresponding to the bladder opening looks quite normal, while the superior one, which I drained through the ectopic ureter, is much dilated (Fig. 3).

Operation. A catheter is passed before the operation into the left normal ureter. Lumbar incision is made; as the kidney is very highly placed a resection of the anterior two-thirds of the twelfth rib is added. The kidney looks larger than normal. It is composed of two parts separated by a groove especially evident on the anterior surface. The superior part which represents only one-third of the whole kidney is composed of a thin layer of kidney substance and by a pelvis as big as a turkey egg drained by a thick and dilated ureter; the inferior part has a normal pelvis and ureter and in this the catheter can be felt. Each section has its own vessels. Those corresponding to the superior portion are very thin. These are ligated and sectioned. The ureter is severed as low as possible, that is to say, about 2 inches above the bladder, and its inferior stump is tied and burned with a cautery. The two kidney halves are separated with a cuneus-like incision in the inferior one (Fig. 1). With deep hæmostatic mattress stitches and superficial capsular stitches the raw surfaces are brought together. The fibrous capsule is stripped away from the removed kidney portion and fixed with a few catgut stitches on the kidney stump, so as to coat it. After reposition of the kidney, the wound is closed with a rubber drain left near the kidney stump. The drain, in this case, was removed after 3 days. Recovery was uneventful, and there was no discharge from the wound. Incontinence disappeared at once.

In reporting the case on which I operated, I aim above all to draw attention to the clinical syndrome of "congenital pseudo-incontinence," and to the possibility of establishing a diagnosis and of determining the anatomical conditions. It is essential to determine the number of the ureters and the anatomical and functional conditions of the pelvis and kidneys. Cystoscopy, ureteral catheterization, pyelography, indigocarmine and pthalein test, blood examination, and sometimes perirenal insufflation of oxygen should be employed.

The involuntary loss of urine also is sufficient in itself to justify operating even if no complications are present. However, as a general rule, the pelvis which corresponds to the anomalous ureter is dilated and infected, and the ureter is often found dilated and irregularly shaped (ureteropyonephrosis or uropyonephrosis).

The following types of operations can be used:

1. Simple ligature or section of the anomalous ureter. This is undoubtedly the simplest operation and is reported to be sometimes successful. However, it absolutely must not be used when infection is present in the corresponding pelvis. I would never employ this method myself because it leaves behind a portion of ureter and the pelvis as a blind dilated sac which, even in the best conditions, is subject to infection because of stagnation of urine.

2. Anastomosis of the ectopic and normal ureters. This is often a technically difficult operation, and a dangerous one because of the possibility of ascending infection.

3. Anastomosis of the two pelves. This operation is also a difficult and sometimes impossible one. It ought always to be completed with the ligature of the supernumerary ureter or, much better, with a high section near the pelvis.

4. The formation of a ureterovesical fistula. This can be done through the ureter by means of endoscopic instruments, or by opening the bladder by the suprapubic route. Such an operation is generally very easily accomplished because, for a certain length, the ureter is adherent to, or is embodied in, the bladder wall. Regarding the first of these methods, I think that used by Hunner is the best. Into the anomalous ureter, he passed a catheter the tip of which was coated

with a rubber-glove finger which could be inflated. In this way the ureter could be made to bulge into the bladder so that a communication was easily established. The same thing can be done even more easily through a suprapubic cystotomy, as in Tauffer and Baum's cases.

5. The severing of the lower portion of the anomalous ureter followed by implantation of the superior stump into the bladder (neostomy). This has been done by the subpubic route with good results. Many times the vaginal or suprapubic route has been used but has seldom been successful. In Pieri's case an implantation through the vagina was followed by an ascending infection which at last led to a nephrectomy. I must also add that in the cases reported as cured, often after several operations, frequently a stenosis of the new opening has been observed.

6. Removal of the anomalous structure. Although a complete cure can be obtained with any one of the already mentioned operations, I believe that removal of the anomalous structure is surgically preferable. Naturally, if only one ureter with an ectopic opening and one pelvis are present, great care must be taken. I believe that in such cases the formation of a vesico-ureteral fistula is more strongly indicated. When a severe infection is present, a nephrectomy may be performed if the other kidney functions normally. In cases of double ureter and pelvis, the operation of choice is heminephrectomy.

Total nephrectomy, which has occasionally been done, is certainly a much simpler operation, but it is recommended only in cases of severe infection of the supernumerary pelvis, with diffusion to the kidney substance, or in the presence of a unique pedicle.

If, as it usually happens, in addition to a double pelvis there is a double vessel pedicle and the two kidney halves are separated (very often, as in my case there is an evident groove), a heminephrectomy is preferable. The superior portion is usually the one to be removed, because, according to the Weigert-Meyer law, the lower ureteral opening will drain the superior kidney half. M. Ascoli, who has widely searched the literature, has found this operation reported only 10 times. My case is the eleventh and the first one of bilateral duplication with an ectopic opening. Even in Gaudiani's more recently published case, heminephrectomy was performed. The number of operations therefore is 12, and in all of these the result has been good.

As to technique, I wish to draw attention to the way in which I separated the fused kidney into its two halves corresponding to the already mentioned groove. A wedge incision was made in the inferior, healthy portion which was to remain in place, so that it was very easy to bring together the two raw surfaces of renal substance and to suture the fibrous capsule tightly (Kuemmel). I think that it is also very advantageous to coat the sutured kidney stump with the capsule stripped away from the excised kidney portion. The suture so covered assures a better hæmostasis and protection against an eventual filtration of urine.

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UTERINE STERILIZATION

By WILLIAM O'NEILL SHERMAN, M.D., F.A.C.S., Pittsburgh

IN an address on "Sterilization of Wounds, the Treatment of Suppurating Wounds and Osteomyelitis (Carrel Method)," delivered by the author before the Royal Society of Medicine in London, October 31, 1916 (4) attention was called to the possibilities of treatment of infection of the uterus by the Carrel method.

A visit to the clinics of Carrel and DePage in July, 1916, gave the impression and conviction that the problems of wound infection had been satisfactorily solved. A rational débridement of wounds within 8 or 10 hours after the receipt of the patient, followed by chemical sterilization with sodium hypochlorite (Dakin's solution), with primary or secondary closure, resulted in union in a majority of cases so treated. The results of the Carrel-Dakin treatment, when compared with those of other procedures, make it the method of choice, especially by those who have had the opportunity and have given the time to study and master its technical details. Its general adoption has been greatly retarded because of superficial observations and scanty consideration of the basic principles involved by visitors to the Carrel and DePage clinics, without a distinct understanding of the underlying surgical, chemical, pathological, and bacteriological principles.

The great lack of understanding and the failure to carry out details, as well as the modification by surgeons who do not understand the method, are the chief causes today of the general misunderstanding and the great divergence of opinion as to the merits of sterilization of wounds with sodium hypochlorite.

The great similarity between wounds of war and uterine infection, gave rise to the hope that if a satisfactory technique could be devised, progress would be made in the treatment of uterine infection. Wounds produced by shells which introduce into the tissues foreign bodies contaminated with soil pollutions, together with the trauma of the soft parts, present very much the same picture as the postpartum or postabortum uterus with its retained secundines, proliferated mucosa, and blood clot, together with the exposure of the raw surface of the uterus at the placental site.

In the great majority of cases, uterine infection at its onset may be considered as local or superficial, while involvement of the parametrium, broad ligaments, peritoneum, and blood stream is a later and secondary extension. It would appear logical to assume that if effective treatment were directed before such extension of the infectious process, arrest or even suppression of the infection can be secured.

The author early recognized the great possibilities of sodium hypochlorite in the treatment of localized infections such as uterine sepsis, and in the aforementioned paper, briefly advocated a technique whereby it would be possible to apply the Carrel principle to the treatment of uterine infection.

With this in mind, the author devised a special armamentarium, consisting of vulcanized cervical pessaries, perforated rubber tubing, introducer, uterine sound, and packer. A brief description of the apparatus was given in this earlier publication (3).

The principle of the treatment consists in the gentle introduction of the pessary into the cervix, followed by the introduction of rubber tubes through the pessary, into the uterine cavity, and the packing of the uterus lightly with bandage gauze so that the tubes are retained in position against the walls of the fundus. They give the appearance of the steel ribs of an open umbrella. The gauze acts as a sponge and gives off to the uterine walls the hypochlorite solution as it is ejected from the rubber tubes. Should it be deemed advisable to remove some of the retained secundines, this may be done in the early cases, provided great caution is observed not to traumatize the mucosa by curettage or instrumentation. It is more conservative to use a small cotton sponge on a holder, and by this means, excessive débris can be gently and sufficiently removed. Curettage absolutely fails to remove all of the infected tissues, and usually is provocative of great harm by setting up active extension of the infection. For this reason, curettage is generally inadvisable.

In this paper, I do not wish to discuss the many factors entering into the cause and prevention of uterine sepsis, but rather to direct attention to the great similarity in the pathology of uterine infection and that of general surgery, with the hope that the principles and methods used in the latter field, to combat infection, will be applied to related obstetrical problems.

One great difficulty in the treatment suggested, is the frequent inability to retain the tubes within

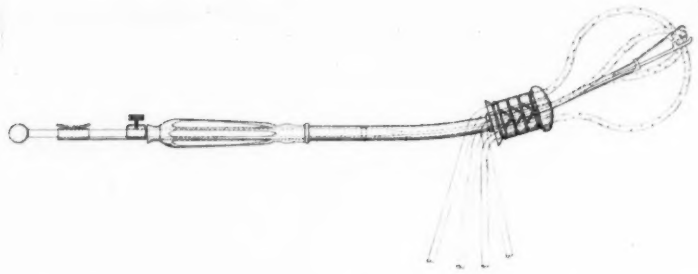

Fig. 1. Hard rubber cervical pessary. Perforations permit of ample drainage with introducer for insertion of perforated rubber tubing.

the uterus when contraction begins. The tendency is for the tubes to be forced into the vagina. It must also be admitted that the treatment is applicable only in early, selected cases, and in hospitals where every possible facility is available to carry out each detail of the method. Because of the dangerous extension of infection following ill-advised, or anything but the gentlest of manipulations, this treatment should be attempted only by those who have specialized in this work, and who have made a careful study of the principles involved.

It is quite true that many patients with puerperal infections are frequently seen only in the late stages when active intervention is contraindicated. Therefore, it is imperative that physicians, nurses, midwives, and the laity be educated to the necessity of active treatment at the earliest possible moment, so that immediate steps can be taken to abort, or suppress, local infection before it becomes general or systemic. Cases in which unnecessary and careless examinations, or intensive instrumentation have been made, and in which infection is probable, should be treated prophylactically immediately following delivery, and before signs of local infection become apparent. It must not be forgotten that in the fulminating types, blood-stream infection and death occur before local symptoms are evident and before any measures can be instituted.

It is conceded that there are causes for pyrexia in the puerperium other than infections of the uterus. If the temperature rises to 100 or 101 degrees F., pulse increasing from 105 to 110, together with the presence of bacteria on smear and culture taken from within the uterus, treatment should be started at once. The diagnosis of uterine infection should be made only by a process of elimination after every other possible factor, such as focal infection, pulmonary or abdominal disturbance, mastitis, plebitis, cystitis, etc., has been excluded. To delay and hesitate in an effort to differentiate between sapræmia and a true uterine infection, is likely to result fatally. It is usually impossible to differentiate in the early stages between them, and it is generally admitted that a sapræmia frequently merges into septicæmia.

There is no doubt but that the indiscriminate use of antiseptic intra-uterine douches has produced much harm and has been of no benefit in the treatment of uterine infection. It is obvious that the best treatment is prevention. Despite exacting precautions and the very best of surroundings, however, infections not infrequently occur. Too often are the attending doctors and nurses censured when every care has been taken, and blame is unwarranted. On the other hand, there are many cases of infection due to repeated examinations, faulty technique, and insanitary surroundings, all of which is more or less within the control of the physician or nurse.

The question of puerperal infection is a serious one and demands the attention of the profession, as there has been little or no reduction in uterine sepsis and mortality during the past 30 years. Whitehouse indicates little change from 1883 to 1902 and from 1912 to 1922 in mortality.

GENERAL PRINCIPLES OF THE TREATMENT OF PUERPERAL SEPSIS

The most generally accepted plan is that of "watchful waiting," as against direct intervention. Active treatment (curettage or intra-uterine douching with useless antiseptics—mercury salts, iodine, the phenol group, silver salts) has resulted in absolute failure to cure and such treatment is more likely to be the cause of a dissemination of the infection.

During and previous to the war, the general failure of all antiseptics other than sodium hypochlorite, to abort or cure infections, resulted in

the division of the profession into two groups: those who had faith in antiseptics as inhibitors or destroyers of infection, and those who believed in the physiological treatment of wounds and infection by saline irrigation and aseptic technique. Notwithstanding the fact that tincture of iodine, solutions of mercury salts, and the phenol groups failed absolutely to combat infection during the World War, thus resulting in a great loss of life and frightful disabilities, there are those today who doggedly continue to treat infected wounds in the blind faith that these useless so-called antiseptics are specifics.

The present general status of the expectant method is largely dependent upon the vital forces of the patient, i.e., if there is sufficient resistance to overcome the infection, recovery is possible, the patient receiving very little in the way of medical assistance. About the only active treatment is the use of ergot, elevation of the patient for drainage, ice to the abdomen, rest, avoidance of cathartics, and such measures.

LOCAL TREATMENT AND TECHNIQUE

No attempt will be made to discuss in this paper other therapeutic measures of admitted value, but attention in the early stages is to be directed toward methods of sterilization of the uterine cavity.

The patient is anæsthetized, preferably with ethylene or nitrous oxide, and placed in the lithotomy position. The external genitals are cleansed with soap and water in the usual manner, and vaginal irrigation with ½ of 1 per cent solution of sodium hypochlorite is given. Picric acid, iodine, peroxide, ether, or alcohol are not to be used as they are incompatible with sodium hypochlorite. Careful inspection of the vagina and cervix should be made, followed by a gentle bimanual examination to determine the size and position of the uterus.

The cervix is grasped with a single tenaculum, and with the blunt uterine sound of the author's design, the distance between the fundus and external os is measured, as well as that between the internal and external os. Subtraction of the difference between the length of the cervix and the measurement from the external os to the fundus gives the distance within the uterus that the perforated rubber tubes can be introduced. For purposes of safety and to prevent any possibility of perforating the fundus with the metallic intrauterine introducer, a further reduction of from 2 to 4 centimeters should be made. This will allow ample distance for the placement of the tubes within the uterus without perforating the fundus.

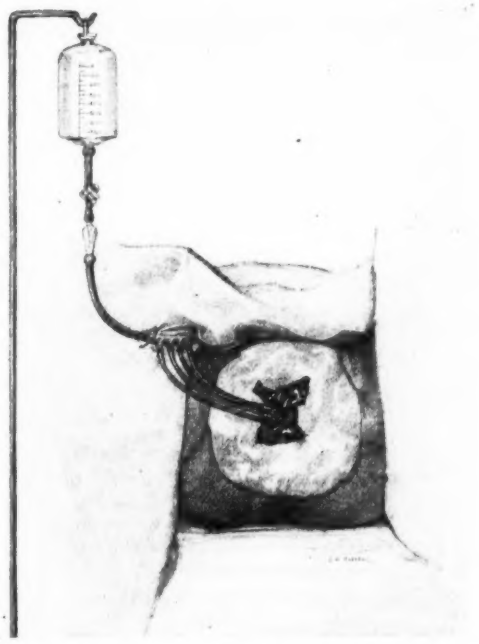

Fig. 2. Vaseline gauze dressing applied to perineum to prevent irritation. Rubber tubes attached to Carrel glass distributor and container; solution is introduced intermittently and *not* by the drop method.

At the same time, the width of the cervical canal should be carefully estimated so that a pessary may be selected which will be small enough to pass without the slightest dilatation or other traumatic force.

The perforated rubber tubes are then placed in a proper sized pessary, a sufficient number of staggered perforations being allowed to permit of a free outflow of the hypochlorite solution from the tubes over the entire surface from the external os to the fundus. When the tubes are threaded into the pessary, sufficient length must be left so that their ends will reach to the vaginal outlet.

The introducer is then placed in the central opening of the pessary, where it grasps and locks the distal ends of the perforated tubes. After it has been determined how far the tubes are to be introduced within the uterus, a set screw on the handle of the introducer is adjusted, and the rubber pessary is carried into the cervix; the tubes are passed up into the cavity of the uterus until the introducer engages with the set screw. The introducer is then released from the perforated tubes and withdrawn from the pessary. The tubes are

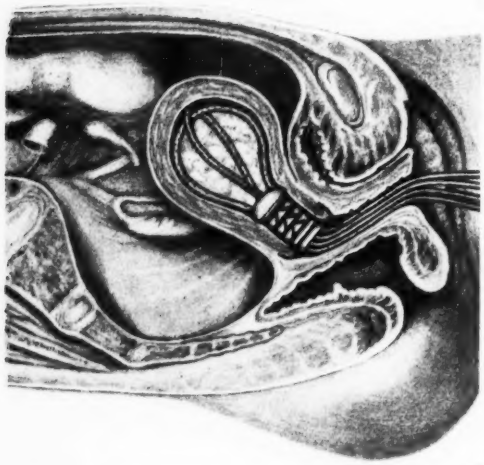

Fig. 3. Pessary inserted into the cervix; perforated rubber tubes spanning the uterus with light gauze pack, permitting instillation of hypochlorite solution and providing ample and free drainage.

left placed within the uterus and the pessary *in situ* within the cervical canal.

The pessary presents its outer surface at the external os. Through the central opening of the pessary, bandage gauze is packed lightly into the uterine cavity in such a manner and quantity that the cavity is entirely filled with gauze, the lower end of the bandage lying free in the vagina. The tubes are thus held in position against the fundus and walls of the uterus, the gauze serving as a sponge which constantly holds and gives off the sodium hypochlorite to the uterine walls.

A small, projecting shelf at the orifice of the pessary permits, if desired, the fixation of a rubber dam cover which encases the tubes and drainage gauze, so that the vagina is protected against any possible irritation from the hypochlorites. This step complicates the general technique and is not essential. In the presence of a vaginal tear with ulceration or infection, such protection might even be undesirable and extravaginal tubes may be placed as indicated.

It must be remembered that the object of uterine gauze is to act as a sponge, and if packed in tightly, it will take up too little of the solution in suspension. The special packer designed by the author is used to introduce the gauze into the uterus. The skin of the external genitals is protected by vaseline strips of gauze and a large absorbent pad of cotton and gauze. The irrigation tubes placed within the uterus and presenting at the vulva, are attached to a glass distributor, which in turn, is connected with a large rubber tubing from the container holding the hypochlorite solution. This container is elevated 3 feet above the head of the patient and the solution is allowed to flow from the container when a stopcock is released; seepage of the hypochlorite solution is observed at the vaginal outlet. At intervals of every hour in day-time and every 2 hours during the night, from 4 to 8 ounces should be instilled. The solution must be injected under pressure, but not enough pressure should be used to force the solution through the fallopian tubes into the abdominal cavity, nor should the solution be instilled by the drop method as is saline in the Murphy drip.

Sodium hypochlorite liquefies the retained secundines and bacteria by a process of oxidation, and ample outflow is permitted through many drainage holes in the cuff of the pessary. As the uterus recovers its tone and contracts, we must expect difficulty in retaining the tubes *in situ*. The bandage gauze in the uterus may be changed every day, but the tubes and pessary need not be changed oftener than every second or third day. As the uterus involutes, smaller pessaries must be used. If the temperature and pulse fail to show marked improvement within 5 to 7 days, treatment should be discontinued, and failure admitted. There will usually be quite a visible change for the better within 3 or 4 days, provided the treatment is started while infection is still localized within the uterus.

The cervical pessaries are made in 4 sizes, with 2 different sets of introducers, and 2 sizes of rubber tubing. It must be understood that extreme gentleness must be exercised at all times and trauma absolutely avoided.

CHEMICAL, PHYSIOLOGICAL, AND BACTERIOLOGICAL PROPERTIES OF SODIUM HYPOCHLORITE

The solvent and antiseptic properties of Javelle water and Labarraque's solution were long known, but they were too caustic to permit of their surgical use, while the ineffectiveness of iodine, mercury, silver salts, and the phenol group have been discussed elsewhere in this paper. It remained for Dakin and Daufresne to devise a method of utilizing sodium hypochlorite of known content in so far as its percentage of sodium hypochlorite was concerned, and of relatively low alkalinity.

By the use of 25 per cent active chlorine (bleaching lime) with the addition of sodium bicarbonate, a solution of constant hypochlorite content (.45 to .5), known as Dakin's solution was accepted as a standard for surgical use. The phenolphthalein

test of the alkalinity is not a reliable chemical test as to causticity and can be only a relative indicator. The hydrogen-ion content is generally accepted as the most reliable index of alkalinity. A .45 to .5 sodium hypochlorite solution as made from bleaching lime, has proved to be an excellent solution when used in connection with the Carrel technique. It requires, however, constant testing because of its instability. It is rather difficult to make or secure a reliable Dakin's solution in the vast majority of hospitals. The hypochlorite solution of greatest stability and lowest alkalinity when combined with sodium chloride makes an almost ideal antiseptic solution because of its bactericidal and physiological properties.

The great superiority of sodium hypochlorite over other antiseptics is due not only to its antiseptic properties in destroying bacteria, but also to its property of dissolving necrotic tissue. A 4 per cent solution of sodium hypochlorite will destroy anthrax and its spores immediately; a dilution of 1:10 will destroy anthrax bacilli and spores in 15 minutes.

What is the chemical action of sodium hypochlorite when it comes in contact with bacteria or with dead tissue? The chlorine of the aqueous hypochlorite has great affinity for the nitrogen of the proteins, setting free nascent chlorine and forming a chloramine. The affinity is so great that the hypochlorite is practically used up within 5 to 10 minutes after its injection into the wound, this being the reason why repeated injections at such frequent intervals are so necessary. Sodium hypochlorite in proper dilution is non-toxic and can be used in any quantity. The author has used 10,000 cubic centimeters during a period of 24 hours in the treatment of empyema, with no deleterious effect. It has little or no destructive effect on living tissues in proper dilution, but seems to have a selective action for bacteria and dead tissues, and is the only great oxidizer at the present time available which can be used freely without danger of injuring or destroying living tissues.

The ideal solution to be used is one that is isotonic: combination of Dakin's solution with low alkalinity and saline content, sodium hypochlorite, .5 per cent; sodium chloride, .7 per cent; and aquæ distillæ, 98.8 per cent.

Chemical sterilization of the surface of living tissue is but a relative term, i.e., reduction of 1 to 2 bacteria to 5 microscopical fields, this average being made from an examination of 20 or more fields. The few remaining bacteria which have not been destroyed by the hypochlorite can be well cared for by the phagocytes and leucocytes.

If sodium hypochlorite can sterilize large empyema cavities, compound fractures, and joints, it is not too much to expect it to bring about similar results in the uterus if used with discretion and full understanding.

In an editorial in the *British Medical Journal* on "Listerism and War Wounds," a review of antiseptics is briefly mentioned. The editorial states: "At the outbreak of the war of 1914–1918, surgeons were far better equipped in knowledge and resources than in pre-antiseptic days. Yet early experiences with gunshot wounds were so disturbing that a feeling of dismay at their inability to check virulent infection swept over all. Were our teachings fundamentally unsound? Had we forgotten the lessons we thought we had learned? The obvious thing was to go back to Lister. To add to the general discomfiture, a most respected bacteriologist wrote most convincingly on the futility of antiseptics in general. New antiseptics were sought and discovered. Eusol came in, then the Carrel-Dakin treatment. The latter certainly would have made a strong appeal to Lister himself. In it is fulfilled one of the principles for the application of which he searched so long, the continuous renewal of an antiseptic which had no marked deleterious effect on the tissues. Wound excision at the earliest possible moment with primary union delayed, or primary suture as the wounds demanded, antiseptic treatment, Carrel-Dakin—these were the principal methods finally adopted as a routine. But it required fully three and one-half years of their evolution on an unprecedented mass of human material."

This editorial is in error as to the time of evolution before its acceptance as routine procedure. It has not as yet been accepted as a routine measure, and when presented in 1915–1916 to many so-called leaders of the profession, it met with rejection, so it has been only by slow stages that the true merits of the method finally have become known. Even today, adverse criticism and strenuous objections are frequently encountered. It will, no doubt, take many years to break down the prejudices and theories before a general acceptance and understanding can be expected. In the interval, many lives will have been sacrificed unjustly. One is curious to know how much more "unprecedented mass of human material" is necessary to convince the skeptical.

The aqueous hypochlorite solutions with low alkalinity, known as Dakin's solution, must not be confused with the chloramines, dichloramines, and similar synthetic products which are derived from coal tar. Chloramines and dichloramines

TABLE I

Number of patients	Duration of irrigation—days
28	2
30	3
29	4
19	5
16	6
8	7
8	8

have little or no solvent properties. It is the great solvent property of aqueous hypochlorites which makes them so useful. It must not be inferred that any panacea or cure-all is being offered.

FREQUENCY OF PUERPERAL SEPSIS

Fothergill states that in a report of Queen Charlotte's Hospital in 1921 dealing with 1700 cases, of which 234 were febrile, 134 cases, 8.6 per cent, were regarded as puerperal pelvic infection. Two of these patients died, a fatality of 1.57 per cent.

A study of British Maternity Hospitals show that the number of cases of pelvic infection varies from year to year, but it appears that 6 to 8 per cent of such infections occur, of which 3 to 4 per cent die; in other words, out of every 1,000 confinements, we may expect 60 to 80 cases of infections, with 2 or 3 deaths.

In a careful analysis of 3,500 deliveries in the United States, Euno reports 300 infections and 10 deaths, i.e., 8.6 per cent infections and 3.5 per cent fatalities.

The estimated number of births in England and Wales in 1920 was approximately 957,782; 7 per cent were infected, or 67,000 cases of puerperal infection and 2,087 deaths from puerperal sepsis were registered in that year. In addition to the births, there were about 2 abortions to every 7 confinements. Thus, there would be 10,000 additional cases of infection after abortion, to arrive at a total of puerperal pelvic infections, which would make 70,000 to 80,000 cases in England and Wales during 1920.

These statistics being used as a basis, it is evident that if the same ratio of infection and births existed in the United States, there were 186,232 cases of uterine infections and 5,587 deaths. In his report on "Uterine Infections in the United States," De Lee says that 6,000 women die annually from puerperal infections in this country.

An estimate of the population of the world in 1920 was 1,748,000,000. If the same ratio existed throughout the world in the same year, there would have been 3,059,000 infections and 91,770 deaths. These statistics are rough estimates, but are not necessarily exaggerations of actual conditions. The death rate for puerperal sepsis in the United States per thousand births is 2.79, or 1 in every 407, and our registration is far from complete.

TABLE II—COLLECTED SERIES OF CASES

Method	Cases	Deaths
M. Androdias (2), cylindrical rubber syringe affixed to thigh with adhesive	152	19
T. R. Campbell Canney (1), rubber tubing within uterus	30	2
Beckwith Whitehouse, large rubber drainage tubes inserted into uterus and sutured to labia	62	5
Paul Titus, author's armamentarium and technique	8	0
Jaques Silbol (5), Carrel tubes carried into the uterus	2	0
Perrazzi, Carrel tubes carried into the uterus.	6	0
Total	259	26

M. Androdias, professor in obstetrics and gynecology at the University of Bordeaux, France, in a report of a series of infections treated by the Carrel-Dakin method, states that 133 patients recovered in from 10 to 25 days after confinement, the average being from 12 to 15 days. Irrigation was discontinued as the temperature came to normal. Table I gives an idea of the duration of the irrigation.

The author suggested this treatment to Dr. Paul Titus, an obstetrician in Pittsburgh, and asked him to make a thorough trial of the specially devised instruments and technique. This was done and he has made a personal communication setting forth the results in 8 cases thus treated.

Titus was able to reduce the temperature and bacterial count of the lochia to normal within 4 to 8 days after chemical sterilization of the uterus was begun, notwithstanding the fact that the treatment was instituted 2, 3, 4, 6, 10, and 12 days respectively after the initial rise of temperature. The cultures were carefully taken by means of intra-uterine culture tubes, and in each case the bacterial count per microscopic field was 60 or more bacteria at the beginning of treatment. In every case in which the treatment was indicated and used, there was a material decrease in the number of organisms within 3 or 4 days. In one patient, the manipulations caused a definite extension of the infection into the cellular tissues of the pelvis, and suggested to Titus that the indications for this treatment are limited after infection is frankly established, to the so-called putrid or "shaggy" puerperal endometritis cases.

The most favorable cases are those in which the infectious process remains localized and is not of more than 2 or 3 days' standing. In such cases, if technique is carefully carried out, they should show definite improvement in 2 or 3 days.

He also states that the treatment is ideal and exceedingly simple in instances of vaginal sloughs and infected perineal sutures. Many times union will still result in a stitched perineum so badly riddled with infection that complete separation and relaxation would ordinarily follow.

Following is a brief summary of the cases treated by Dr. Titus:

CASE 1. Mrs. M. McC., No. 6711, had a normal delivery with slight midline tear on February 21, 1917. She had a chill on the third day and her temperature was 100.4 degrees and her pulse, 110. On March 5, the findings from uterine material showed a bacterial count of 60 or above per microscopic field; diplococci, pneumococci, and staphylococci. On March 6, pessary and tubes were inserted; blood count showed 24,000 leucocytes. March 8, pessary and tubes were re-inserted; there were 10 bacteria (average) per microscopic field. March 9, the blood count showed 20,000 leucocytes. March 11, there was an average bacterial count of 6 per microscopic field. March 12, the blood count showed 14,000 leucocytes. March 13, the pessary and tubes were removed. March 15 and 16, the temperature and pulse were normal; no blood culture was taken.

CASE 2. Mrs. I. A. A., No. 2268-A., had an incomplete abortion following criminal introduction of a bougie. On March 4, 1917, the fetus was passed. The patient had chills and fever during the night and considerable hæmorrhage. The next day, she was first seen by the hospital service. Her temperature was 103; pulse, 120. At 10:00 p.m. a foul-smelling placenta and membranes were removed under anæsthesia. Pessary and tubes were inserted following the operation. The uterine bacterial count showed 60 or more bacteria per microscopic field. The blood count was 3,460,000 red blood cells, and 19,400 leucocytes. On March 7, the tubes and pessary were changed. Temperature and pulse were normal. The patient's convalescence was uneventful.

CASE 3. Mrs. E. F., No. 4794, had a normal delivery on December 27, 1916. On January 2, 1917, the patient's temperature was 101 degrees and her pulse was 120. On January 5, the temperature was 104.4; pulse, 160. Vaginal smear showed many gram-negative diplococci, 60 or more to the field. These were probably gonococci. January 9, the pessary and tubes were inserted and were re-inserted with change of gauze on January 10, 12, 15, 17, and 20. January 26, the pessary and tubes were removed. Temperature was 100 degrees; pulse, 106. February 4, the temperature was normal.

CASE 4. Mrs. Anna M., No. 6836, was delivered on March 14, 1917, at home. On March 17, the patient was admitted to the hospital and her case diagnosed as pneumonia with local peritonitis and puerperal sepsis. The temperature was 103.6; pulse, 140. A blood count showed 10,200 leucocytes. March 18, cultures were taken from the uterus. Retained secundines and remains of small blood clot were very foul. Pessary and tubes were introduced. Laboratory findings from the uterine material showed a bacterial count of 60 or more bacteria per microscopic field; on the smear there were 3 bacilli per microscopic field; 3 diplococci per microscopic field; and a few streptococci. The blood culture produced a growth of bacillus proteus bulgaris. Leucocyte count was 9,000. March 19, bacterial count showed 60 bacteria or above per microscopic field; bacilli, diplococci, and red blood cells. On smear and on culture there was a growth of bacillus proteus bulgaris. Leucocyte count was 10,000. March 20, the bacterial count showed 60 or more bacteria per microscopic field. Bacilli and diplococci were found on the smear; bacillus proteus bulgaris were found in the culture. The leucocyte count was 10,000. March 21, the blood cultures were negative; the leucocyte count was 11,000. Leucocyte count on March 22 was 7,000. March 23, the bacterial count showed 60 or more bacteria per microscopic field. On the smear there were red blood cells, cocci, and bacilli. The leucocyte count was 6,800, and the next day it was 7,000. The bacterial count on March 26 showed 2 bacteria per microscopic field; and on March 29, there were no organisms. The blood cultures were negative on March 21 and 27. April 9, the leucocyte count was 7,400. On April 13, the temperature was normal and the pulse was 110 to 100.

CASE 5. Mrs. J. R. H., No. 6488, had a normal delivery on December 28, 1916. On January 3, 1917, a breast abscess was noted. Temperature was 102.4; pulse, 110. January 13, there were 60 bacteria to the microscopic field. Pessary and tubes were inserted and then re-inserted on January 15, 17, and 19. January 18, the bacterial count was negative and the next day the temperature was normal. On January 22, the tubes were removed.

CASE 6. Mrs. H., No. 6493, was admitted to the hospital on the eight day of puerperium. On March 31, 1917, there was spontaneous delivery. On April 3, patient had chills with rise of temperature to 105 degrees. April 4, 5, and 6, the temperature was 103 degrees. April 7, patient was admitted to the hospital. Pessary and tubes were inserted at once, and re-inserted April 7, 9, 12, 14, and 17. April 7, the uterine culture showed 60 or more bacteria per microscopic field; the smear showed pneumococci and bacilli; the growth was staphylococci. The blood culture was negative, and the leucocyte count was 13,200 on that day. April 9, the bacterial count was 60 or more per microscopic field. The smear showed staphylococci. There was no growth. The leucocyte count was 12,000. The bacterial count on April 11 was 60 or more per microscopic field. The smear showed no growth. Blood culture was negative. April 12, there was an average of 3 bacteria per microscopic field; the leucocyte count was 16,600. April 14, there was an average of 1 bacterium per microscopic field. The temperature was normal on April 18.

CASE 7. Mrs. Amelia H., No. 6707, had a forceps delivery with slight vaginal tear and three sutures on February 6, 1917. On the fourteenth, the patient had chills and a temperature of 103.8 degrees; pulse was 132. Pessary and tubes were inserted on the fifteenth and re-inserted on the eighteenth and nineteenth. Bacterial count from the uterus showed 60 or above per microscopic field on the fifteenth. The leucocyte count was 25,200. On February 18, there were 4 or more bacteria per microscopic field; and the leucocyte count was 17,000. The next day the leucocyte count was 13,500. On the twentieth, there were 8 or above bacteria per microscopic field. The material was obtained direct from the uterus by means of a glass catheter and syringe. Each specimen proved on agar to be pus streptococci; the second culture showed an average of only 2 diplococci to the field. The third specimen showed short-chained streptococci, averaging 2 chains to the field. There were 15,000 leucocytes. The next day a leucocyte count was taken and showed 14,600; on the twenty-second, the count showed 13,400; and the next day it was 12,800. On February 23, the pessary and tubes were removed. On February 27, the patient's temperature became normal.

LOCHIAL CHANGES

In 1919, Professor Perrozi (8) in discussing "Microbes in Lochia" in cases treated by this method, states: "The lochia in puerperal women examined by me was ordinarily cleared of bacteria in the first and second days following labor. On the third day in the presence of infection, there was a sharp rise in the percentage of bacteria (100 to 400 to every microscopic field). The most favorable time for starting the Carrel irrigation was in the first period, i.e., the incubation period. In the less serious cases, 4 or 5 days were sufficient to sterilize the uterine cavity, in the more severe cases, it took 7 or 8 days."

If there is not a progressive diminution of the bacteria, or should they remain at the same level, one should look for some error in technique. Possibly the tubes are kinked or obstructed and closed by the presence of blood clots. There is a tendency during the first few days for the lochial secretions, débris, blood clot, etc., to clog the irrigating tubes. When the pressure in the container is increased, free egress of the solution from the tubes can be secured. The gross characteristics of the lochia change rapidly, so that within 4 or 5 days it is a scanty, thin, transparent secretion, free from odor. With this change, there is usually general systemic improvement due to the diminution of septic and toxic process.

Bacteriological examinations of lochia and retained contents should be made at each dressing. They will be of great assistance when studied in conjunction with clinical evidence, in deciding when the infection is under control.

Bacteria appear very abundantly in the febrile puerperium after 24 to 36 hours, and the cocci are usually the last bacteria to disappear.

CONCLUSIONS

1. Irrigation of the uterus with .5 solution of sodium hypochlorite, of low alkalinity, in combination with hypertonic saline solution, destroys bacteria and dissolves blood clot, placental tissue, and débris without destroying living tissues and leucocytes.

2. If started early, this treatment may arrest local infection and prevent extension to adnexa and blood stream.

3. Septic endometritis, puerperal or postabortum, has been cured by the intermittent irrigation of the uterus with sodium hypochlorite solution.

4. Repeated bacteriological examinations which are recorded on bacteriological charts are contributory evidence of the state of the infectious process.

5. This method of treatment should be used only in well equipped hospitals, by skilled operators, because special technique and armamentarium is necessary, and keen judgment is required in the selection of cases. Moreover, ill-advised or carelessly performed attempts at such treatment will cause traumatic extension of the uterine infection.

6. The treatment is most useful in the so-called "putrid" or "shaggy" puerperal septic endometritis of mixed bacterial origin, with marked subinvolution of the uterus. If extension to the parametrium has occurred or is suspected, attempts at the treatment should not be undertaken.

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ARE PICRIC ACID AND MERCUROCHROME SOLUTIONS LOCALLY ANÆSTHETIC?

By DAVID I. MACHT, M.D., LL.B., Baltimore, Maryland
Director of the Department of Pharmacology, Johns Hopkins University, School of Medicine

PICRIC acid and oxymercuridibromfluorescein have been used considerably in the surgical treatment of burns, the former having been employed for a longer time than the latter. Solutions of these two drugs are highly colored and stain the skin. Picric acid solutions of 0.5 per cent or stronger have been painted over or applied as in dressings over burnt surfaces, and according to some authors have been found to be exceedingly efficacious. Thus Hare in his *Practical Therapeutics* states: "It has been found exceedingly efficacious in solution in the treatment of severe burns and scalds." The same author also speaks of 5 per cent solutions of picric acid as being antiseptic so that it may be used to disinfect the skin. It is well known, however, that this chemical, when absorbed into the system, will produce renal irritation and other signs of poisoning so that its use over extensive areas, and in cases of deep burns, is contra-indicated as absorption might occur and lead to poisoning.

In the last few years, various surgeons have been employing solutions of oxymercuridibromfluorescein or mercurochrome-220 soluble not only as an antiseptic but also as a dressing for burns of the first and second degree. Application of this drug has been claimed to be beneficial not only by virtue of its powerful antiseptic properties but also as a relief to the pain following burns and scalds. Mercurochrome poisoning by absorption from the skin has never been reported, and in general the toxicity of this drug is much less than that of picric acid (7). In connection with these uses of picric acid and Mercurochrome-220 soluble, the author deemed it desirable to inquire into the mechanism of their sedative effect on burns and scalds and more particularly to ascertain whether these solutions exhibit any locally anæsthetic properties on the nerve endings of the affected areas.

The methods employed in this experimental study were the well known classical procedures for determining and analyzing the local anæsthetic effects of drugs. Three methods were tried in the present study. In the first series of experiments, the local anæsthetic effects of the drugs were studied on the sensitivity of the rabbit's cornea. The reflexes following the touching of the cornea before and after instillation of the solution into the conjunctival sac were studied. By this method no evidence of local anæsthesia was obtained after instillation of either dilute picric acid or mercurochrome solutions. In this connection it was found that picric acid by virtue of its acidity was much more irritating to the eyes than mercurochrome solutions. Indeed mercurochrome has been employed successfully in opthalmological practice by Clapp and Martin (2), Burnett and Gaus (4), Gradle (3), Boeckmann (1), and others.

In a second series of experiments, the anæsthetic properties of the solutions were tested by the frog-skin method. As is well known to all physiologists and pharmacologists, this method is practiced as follows: The brain of a healthy frog is pithed but its spinal cord is left intact. The frog is then suspended and each leg is dipped into a weak solution of acid. The irritation of the acid on the sensory nerve endings of the skin produces a reflex retraction of the limb from the beaker containing the acid solution. The skin is then washed off by dipping several times in fresh water. The same limb is then immersed for a definite number of minutes into the solution to be tested and after the given exposure to the unknown solution, its response to irritation by the acid is again determined. In this way it can easily be determined whether or not a local anæsthetic effect has been produced. Such a local anæsthetic effect is due practically entirely to a local action on the skin, there being very little absorption into the general circulation in the short time through which the experiment is performed. The author has repeatedly tested solutions of picric acid and mercurochrome-220 soluble for their local anæsthetic effects according to this method, and in no instance was any local anæsthesia produced by the drugs even after an exposure of 15 minutes.

The third method of investigation was the study of the effects of the solutions on the conductivity of sensory and motor nerve fibers according to the well known pharmacodynamic methods described in treatises on experimental pharmacology. The experiments performed were made on the sciatic nerves of cats and dogs. After the exposure of the nerve and the cleaning of its

sheath, a pledget of cotton soaked in a given solution is applied to the nerve trunk for various periods of time. A blood pressure and respiratory tracing is recorded on a kymograph and the effects of electrical stimulation of various intensities applied above and below the "block" are studied on the blood pressure, and the respiration curves on the one hand, and on the contraction of leg muscles on the other hand. In this way, when a typical local anæsthetic such as cocaine is applied to a nerve, pharmacologists have found that the conductivity of the sensory nerve fibers is paralyzed long before that of the motor nerve fibers, but that after application of strong solutions of the local anæsthetic for prolonged periods of time the motor fibers are also finally depressed or completely paralyzed. The author studied the effect of application of solutions of picric acid and mercurochrome to nerve trunks in this way and found that they produced absolutely no effect on the conductivity of either sensory or motor nerve trunks.

It is, therefore, evident that neither picric acid nor mercurochrome, employed in the treatment of burns, possesses what may be called true local anæsthetic properties. Their sedative effects in cases of burns must be explained other ways. It is possible that the acid solutions of picric acid produce protein precipitates which act somewhat as protectives. On the other hand, the acid properties of tri-nitrophenol are not conducive to the relief of pain. The action of mercurochrome solutions in burns must be explained in other ways. This drug does not precipitate proteins and, therefore, cannot be said to form a protective layer of an albuminate on burns. It is possible that it may form some other loose combination with body juices. Its sedative effect must also in a measure be due to its slightly alkaline reaction. It is known clinically and has also been proved experimentally that alkalies are much less irritant to the tissues than are acid solutions.

The author also carried out another series of experiments relative to the combinaton of the solutions of the two drugs with a local anæsthetic. As was shown some years ago, benzyl alcohol or phenmethylol possesses powerful local anæsthetic properties (5). Two and 3 per cent solutions of this drug can be and have been employed as local anæsthetics in surgery (6). In addition to their local anæsthetic properties, such solutions are also mildly antiseptic (8) and it has been shown by the author that benzyl alcohol has very low toxicity indeed. The author, also, experimented with mixtures of picric acid with phenmethylol on the one hand and mercurochrome solutions and phenmethylol on the other hand. By incorporating 1 or 2 per cent of phenmethylol in such solutions it was found that they become distinctly anæsthetic on local application as determined by the methods already described. It is, therefore, suggested that the addition of phenmethylol to these solutions may serve a useful purpose.

SUMMARY

1. Solutions of picric acid and oxymercuridibromfluorescein (mercurochrome-220 soluble) were tested in regard to their local anæsthetic properties by a well known pharmacological method and were found to be not locally anæsthetic.

2. The sedative effects of mercurochrome and picric acid solutions in the treatment of burns and scalds must therefore be explained in other ways.

3. By incorporating 1 or 2 per cent of phenmethylol or benzyl alcohol with these drugs, such solutions can be rendered locally anæsthetic and may, therefore, become more useful for clinical purposes.

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EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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WILLIAM J. MAYO, M.D. . . . . Chief of Editorial Staff

JULY, 1928

ASPIRATION VERSUS EMBOLISM IN POSTOPERATIVE PNEUMONIA AND PULMONARY ABSCESS

IN addition to the massive and usually fatal embolus caused by the separation and mobilization of a large fragment of a thrombus, occupying some such large vein as the femoral or the iliac (gross embolism), there is a second form of embolism, of more frequent occurrence, which may give rise to symptoms simulating pneumonia, or lead to pulmonary abscess. This condition (minor embolism) was lucidly described by Conner in cases of typhoid fever and later in other cases of apparently healthy persons. Its significance as a postoperative complication was suggested in 1900 by Mikulicz. It is extremely difficult to differentiate at the necropsy table between areas of pneumonia, arising on the basis of an infarct, and those resulting independently or from aspiration, and of late years Cutler and others, following Mikulicz's suggestion, have come to the conclusion that the large majority of the postoperative pneumonic conditions, formerly considered to be due to the anæsthetic and infection of the lung through the respiratory tract, are actually embolic in origin. Cutler arrived at this point of view as a result of an extensive clinical study supplemented by experiments in which he and his associates were unsuccessful in dogs, as others had been, in producing pulmonary infection by the aspiration route, while succeeding with infected emboli.

Fetterolf and Fox and more recently Schlueter and Weidlein and Holman, Chandler and Cooley have contributed further experimental evidence that infected emboli may be responsible for the development of pneumonia and pulmonary abscess.

As a result of the studies quoted, there is a growing conviction that the adherents of the embolic theory of postoperative pneumonia and abscess have the best of the argument, and yet there is reason for hesitation before accepting their conclusions. The results obtained in the experiments cited were by no means uniform and apparently even a virulently infected embolus may produce, in an otherwise healthy lung, nothing more than a mild inflammation, all signs of which rapidly disappear. In actual practice, especially in virtually aseptic operative fields, it is somewhat difficult to imagine the occurrence of virulently infected emboli. Furthermore, as Conner found in his study of pulmonary infarction in typhoid fever, pleural pain and hæmoptysis, while not constant, are common symptoms in embolic disease; while in acute postoperative pulmonary complications, particularly those that start during the first two or three days after operation, as most of them do, pleural pain and hæmoptysis are noticeably lacking.

Cutler and Schlueter compiled from the literature 1,908 cases of pulmonary abscess of which 30 per cent were postoperative. They did not attempt to explain the remaining 70 per cent, but apparently regarded abscess following pneumonia or bronchiectasis as essentially different from abscess developing after an operation. Smith takes exception to this. There is no material difference in the bacteriology of 56 cases from the literature in which the predisposing cause was known and in which bacteriological and pathological studies had been made. Ten of these were postoperative and 46 spontaneous, post-bronchiectatic, post-pneumonic, and so forth. In all lesions two or more of the following organisms were found, spirochetes, fusiform bacilli, cocci, and vibriones, an assortment that frequently occurs in tonsillar crypts and around the teeth. These data Smith regarded as offering strong presumptive evidence that the oral cavity was the usual source of infection in both non-operative and postoperative pulmonary abscess, and he therefore attempted to produce pulmonary abscess in mice, guinea pigs, rabbits, and dogs by intratracheal inoculations of bloody material obtained from about the teeth of patients with pyorrhœa. He anæsthetized the animals with ether and introduced the material into the trachea so that it trickled down into the lungs, a technique designed to simulate the circumstances under which an anæsthetized patient aspirates material from the mouth. By this procedure he succeeded in producing aspirative pneumonia and abscess where others had failed. Fifty per cent of his animals died of pneumonia and 20 per cent developed pulmonary abscess. The three dogs presented no pulmonary lesions. The absence of effect in these and in the animals that remained well, he explains by natural resistance, by a difference in dosage, or by an active cough reflex.

In view of the results of Smith's recent experiments it would seem somewhat hasty to accept the rather radical suggestion of the exponents of the embolic theory that all effort to limit the frequency of postoperative pulmonary complications be directed to improvement of surgical technique.

RUSSELL M. WILDER.

POSTOPERATIVE SURGICAL INTERVENTION

CONSIDERABLE stamina is required to initiate and carry out postoperative surgical procedures. Possibly this is because of a fear of reflection on the surgical skill exercised primarily or because a secondary operation to relieve a complication is often blamed for what may have been an inevitably unfavorable termination. Clinical and surgical judgment are often taxed to the utmost in these emergencies. Too often the decision to intervene surgically is delayed beyond the time of greatest safety and possible benefit to the patient.

C. H. Mayo, referring to exploratory investigation as a primary operation, often states that he has seen no harm come from early incision when the clinical details are obscure but that many times the mortality is high or the benefit small if operation is delayed until the condition is self-evident. The same dictum may be applied to postoperative procedures and is a great comfort in times of stress.

Bleeding and dyspnœa following thyroidectomy may endanger the patient. Pressure from blood clots, bilateral or even unilateral recurrent laryngeal nerve injury with cord paralysis, and rarely collapse of the trachea, are the usual obstructive factors. Prompt opening of the wound, turning out of clots, catching bleeding vessels, or performing tracheotomy are life saving measures. This usually

results in wound infection and probable subsequent tissue distortion but this is a minor incident.

Following gastric surgery there is often a fertile field for what Bartlett has called clinical clairvoyance. Indeed, the cause of the trouble may not be clear after exploration.

When prompt, frequent, and intelligent lavage demonstrates that the stomach is not emptying, not too much delay should be engaged with the blood chloride balance, intravenous glucose, and rectal nutriments. Freeing of a distal jejunal limb twisted or folded in fresh plastic adhesions, entero-enterostomy between the proximal and distal loops of the jejunum, or jejunostomy for drainage and feeding purposes are efforts that are richly rewarded, if opportune.

The convalescence, often unduly prolonged, following pleural drainage may be shortened or a fatal termination avoided by alert judicious surgery. Retention of pus is usually the cause of the fixed or increasing debility. Enlarging the opening, placing it lower to drain the most dependent point in the abscess, or raising it to a higher level if contraction or formation of granulation tissue has raised the floor of the cavity, are valuable measures. It is never amiss to consider the possibility of the presence of incarcerated drainage tubes or gauze packing.

Surgery of the biliary tract sometimes presents the postoperative problems of bleeding, common duct stenosis, or escape of bile into the abdominal cavity. Probably there is more reluctance in re-opening this field than any other. Bleeding from the cystic artery may be quickly fatal and that from the liver notch very alarming. Persistent or promptly appearing jaundice brings up a host of speculations, none of them pleasant. Bile produces a low grade peritoneal irritation and stupefying reaction that is sometimes difficult to analyze. Timely, skillful, secondary surgery is a great beneficence in this field.

Appendicitis, strangulated hernias, and intestinal resections all carry potential postoperative difficulties in which reasonably prompt action may be the patient's only salvation. Stagnation or reversal of the fæcal current from an ileus, peritonitis, or frank obstruction usually accounts for the picture presented. Jejunostomy is not always successful under these circumstances but it often results brilliantly in a seemingly hopeless situation and its performance adds very little to the patient's crushing load.

McVicker, Crile, Walters, and others have introduced valuable measures preparatory to operation that obviate many postoperative complications. Many things can be carried out during an operation that are likewise efficient. Exploration for possible unexpected pathological conditions with exposure and isolation of the involved area with packs that also protect adjacent tissues from injury or contamination is good prophylaxis. Certain hæmostasis, careful dissection, the clamping and cutting of important structures well isolated under vision helps to avoid subsequent trouble. Placing a tube in the jejunum or ileum when peritonitis, ileus, or temporary bowel obstruction are imminent should always be considered. Few patients are so desperately ill that necessary haste makes the application of these principles impossible.

Continuous consideration, balanced judgment, and real stamina are called upon not only to avoid unnecessary postoperative invasion but also to initiate action while there is reasonable safety and chance for relief.

PAUL A. WHITE.

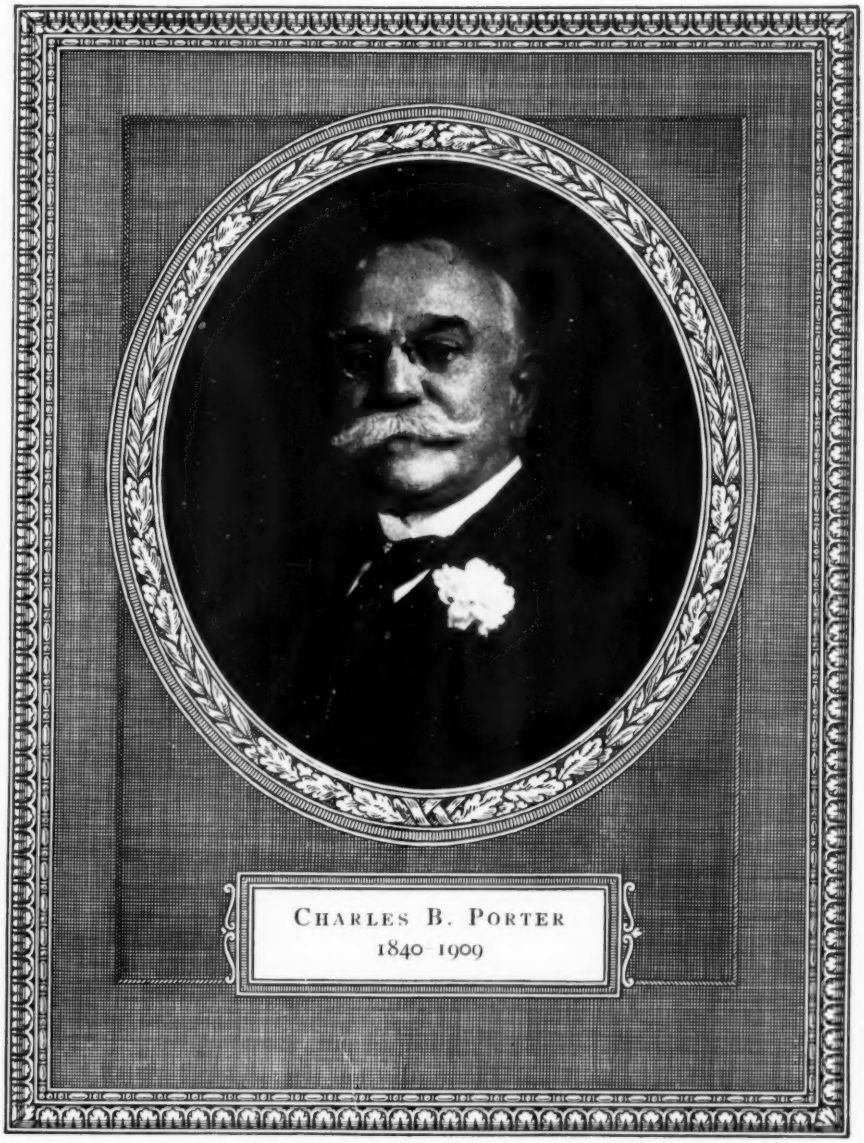
MASTER SURGEONS OF AMERICA

CHARLES BURNAM PORTER

CHARLES BURNAM PORTER was born in Rutland, Vermont, January 19, 1840, and died in Boston, May 21, 1909. He came from good old English stock. His original American ancestor, Daniel Porter, came to this country about 1650 and settled near Farmington, Connecticut. He was a surgeon and bone-setter of note.

The story of the Porter family is that of one of the most remarkable medical families in America, and it is doubtful if it could be duplicated. Apparently the male descendants of Daniel Porter throughout seven generations in this country were all doctors. Charles Burnam Porter, the subject of this sketch, was the seventh physician in his family in direct descent. There have been altogether eighteen physicians of this name of whom there is a record. The son of Dr. Porter, Dr. C. A. Porter, is a prominent surgeon practicing in Boston at the present time. He, too, has a son contemplating the study of medicine. All of the members of the family lived active lives in western Connecticut, Massachusetts, and Vermont. Several of them attained considerable reputation as surgeons and bone-setters. James Porter, the great-grandfather of Charles Burnam Porter, was a Vermont Tory. He received a commission as surgeon under the British flag, and served in Howe's Army of invasion on Long Island.

Charles Burnam Porter grew up a vigorous out-of-doors lad in Vermont. At the age of eighteen, he entered Harvard University, and was graduated with the A.B. degree in 1862. He at once began to study medicine in the old North Grove Street School, and passed from there to the Massachusetts General Hospital, where he served as interne in 1864. He was graduated in medicine from Harvard Medical School in 1865, during the Civil War. He immediately went to Washington, looking for Army Service, and, by dint of great perseverance, succeeded in obtaining an appointment on the staff of one of the principal military hospitals, where he served with great credit until the end of the War. Within a short time after receiving his appointment, he was placed in charge of one of the large surgical wards. It is a matter of record that he had at one time as many as seventy-four cases of compound fracture under his care, which in those days of septic wounds meant a deal of dressing and personal attention.



CHARLES B. PORTER
1840-1909

UNIV OF MICH

In June, 1865, he was married to Miss Harriet A. Allen, of Cambridge. At the close of the War, he returned to Boston. Three years later, he went abroad with his wife and two children, studying for nearly two years in Vienna, Berlin, and Paris. Returning to Boston, he received important professional appointments in rapid succession—physician to Out-Patients, Massachusetts General Hospital in 1866; district physician, in 1866; physician to the Boston Dispensary in 1867; assistant demonstrator of anatomy, Harvard, in 1867; demonstrator of anatomy, under Oliver Wendell Holmes in 1868; visiting surgeon to the Massachusetts General Hospital in 1875; instructor in surgery, under Henry J. Bigelow, in 1879; assistant professor of surgery in 1882; professor of clinical surgery in 1887, which position he held until 1903, when, by reason of the age limit, he automatically retired.

Dr. Porter had taught medical students continuously for 37 years, a record almost equal to that of Henry J. Bigelow's 40 years in the same institution. As a result of his work through those 37 years, he came to be regarded as one of the soundest clinical surgeons and one of the best teachers in New England; a man of singular simplicity of life; rarely given to speech in public, or the writing of professional papers. The arts of the medical politician were foreign to his make-up, and his steady advancement in Harvard and the Massachusetts General Hospital were through merit alone. While his appointments at the Harvard Medical School and the Massachusetts General Hospital were purely surgical in character, he always combined general practice with surgery, and had for many years a large private practice in addition to his hospital and medical school work.

His contributions to medical literature were not voluminous, consisting chiefly of papers read before medical societies and publications in medical journals on a wide variety of subjects in which, at the time, he was particularly interested. Perhaps his special interest lay in the line of plastic surgery, in which he excelled. No one of his numerous assistants or students can look back upon his service with Dr. Porter without recollecting with great pleasure and satisfaction the manual dexterity, technical skill, and surgical judgment which he constantly exhibited in all of his work. It was a real joy to watch the neatness and exactness and dispatch which always characterized his work. His flaps always fitted perfectly; he never had to trim them. In typical operations of all kinds, he was a past master. His work was made more efficient, undoubtedly, by his long anatomical training and familiarity with the teaching of operative surgery.

An outstanding characteristic of Dr. Porter's work was the uniform kindness and consideration which he always showed to his patients, and to his staff as well; a quality of heart which greatly endeared him to all those who served under him, in fact, to everyone associated with him in any capacity. There

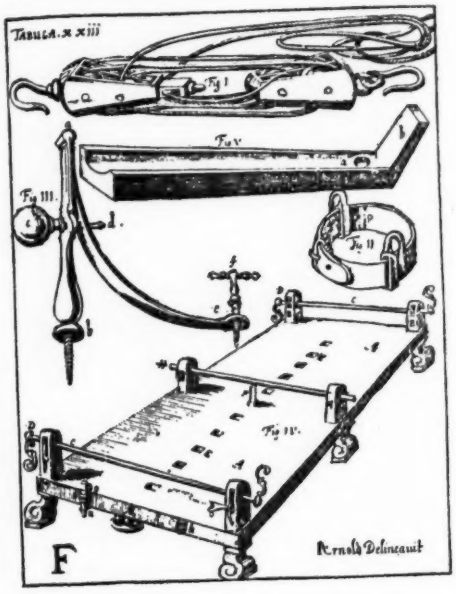
lingers still in the memory of those who so greatly profited by his professional counsel and personal kindness, grateful recollections of the great privilege and benefit they obtained through association with him.

The qualities of head and heart here so inadequately set forth; the long years crowded full of fruitful service to his fellow-men as teacher and practitioner of surgery; his contributions to the science of surgery and his extraordinary proficiency in the practice of its art, all entitle Charles Burnam Porter to an honored place among the master surgeons of this country.

J. M. T. FINNEY.

TABUL.
XLII.
Jonas Arnold
Delineavit

TABUL. XXXVI.
Fig. I.
Fig. II.
Fig. III
Fig. IV
Fig. V.
Fig. VI
Fig. VII.
I


TABUL. XXIII
Fig I
Fig V
Fig III.
Fig II
Fig IV.
F
Arnold Delineavit

THE SURGEON'S LIBRARY

OLD MASTERPIECES IN SURGERY

ALFRED BROWN, M.D., F.A.C.S., Omaha, Nebraska

THE SURGICAL ARMAMENTARIUM OF JOANNUS SCULTETUS

A REVIEW of the surgical books of the seventeenth century shows that the major portion of the literature of that period consisted almost wholly of the description of clinical cases, mere reiteration of details with practically no attempt made to draw conclusions from them which might establish either a surgical pathology which would prove acceptable or a therapeutic method which could stand the test of continued application. At first blush this fact appears remarkable and almost unbelievable that a number of men such as these were—capable of clear headed observation and with such an enormous mass of clinical material at hand on which to employ this observation—should be content with the mere description of individual cases and then let the matter rest. For the explanation of this fact one must turn from surgery and look into the condition of its sister science—internal medicine.

The seventeenth century was the era of the introduction of the systematists in medicine. As Paracelsus had been the most prominent medical bolshevist of the sixteenth century, it was natural that some of his peculiar ideas—especially those which had to do with the supernatural and mystic—should be revamped and brought forward as a system to explain the ills that flesh is heir to. The humeral theories of Hippocrates and Galen were no longer tenable, so, adopting nearly all that was bad in Paracelsus, such as his weapon salve and sympathetic powder, his followers harked back to the Hermetic books and Cabala, and aligned themselves with the Zoroastrian doctrines. These doctrines of Paracelsus had a good deal of chemistry of a sort in them and were later to serve as the stepping stone to a more sane chemical idea, but before this came about there was an intermediate phase in which these pantheistic ideas were amalgamated into a system of mysticism and piety founded upon a chemical basis by Van Helmont, who was a chemist, a vascillating doubter of all fact, and finally a theosophist. The keystone of the system was that the fundamental basis upon which the body depended for its existence was the "Archeus" and anything wrong with the body was due to a change in it.

Following Van Helmont came the Iatrochemical (Healing Chemical) system of Sylvius which was based on chemistry as developed from alchemy and proved to be the infant beginning of modern chemistry. Though being unwilling to relinquish entirely the idea of a fundamental "spiritus" and innate heat of the heart, nevertheless the circulation of the blood and action of the lymph and chyle was recognized and a system built upon these in an attempt to harmonize the old theories and newer facts. The fundamental basis of general pathology was that health was due to a process of fermentation in the body without either an acid or alkaline salt—a condition of perfect neutrality. Let either one, acid or alkali, become predominant and disease appeared.

As opponents of the iatrochemists, came forth the iatromechanical school, which founded its ideas on the solid portions of the body which they weighed and measured, calculating from the mathematical results the various errors of the body in disease. Respiration was based on the mechanics of the thorax, digestion on trituration of food and so on through the functions of the body. The basic idea was that health was determined by a smooth and even carrying on of mechanical and physical functions.

With these various unproven and in many instances far fetched ideas serving as bones of contention to be fought over by the medical men, the surgeons realized that they, in their field, were dealing with facts and had better let others theorize as they wished. Consequently, they held themselves to this line and contented themselves with describing and publishing surgical conditions as they observed them. Surgical technique was, however, improving and its tools were multiplying by leaps and bounds. It was, therefore, natural that an attempt should be made to standardize this part of surgery as Dalla Croce had done nearly a century previously.

This task was attempted by Johann Schultes, better known as Scultetus, the city physician of Ulm, who published the fruits of his labors in a book called *The Armamentarium of Surgery* in 1653. The volume is of particular interest because of the beautiful and numerous illustrations, which show not only the instruments themselves but also the technique of many surgical procedures. The "Scamnum Hippocrates" or fracture table is shown in the lower right illustration and the beginning of a Cæsarean section in the upper.

The "armamentarium" is followed by the usual "century of observations," a record of a hundred cases of more or less surgical interest, but the popularity of the book, which went through many editions, was determined by its value for technical purposes.

REVIEWS OF NEW BOOKS ON GYNECOLOGY AND OBSTETRICS

By Palmer Findley, B.S., M.D., F.A.C.S., Omaha, Nebraska

We are indebted to Herbert R. Spencer for a historical sketch of *British Midwifery*,[1] embracing the periods of 1650 to 1800. In the introduction, we are given the story of the Chamberlains and the midwifery forceps. In succeeding chapters, the author presents sketches of the lives of such men as William Harvey, John Maubray, Sir Fielding Ould, William Smellie, John Harvey, William Hunter, Charles White, William Osborn, and Thomas Denman.

These biographical sketches are accompanied by excellent photographs of the founders of British midwifery. In chapter II we have a recital of the "lampoons and diatribes" waged against the man-midwife. Chapter III presents an historical sketch of puerperal fever and chapter IV gives a brief review of the contributions of British obstetricians to the beginning of the nineteenth century.

The story is well told and will be appreciated by all who are interested in the development of the obstetric art.

A NOVEL feature of the admirable work of Banister and his associates[2] is an historical sketch of Queen Charlotte's Maternity Hospital founded in 1729 and reputed to be the earliest lying-in hospital in Great Britain. The sketch is embellished by a picture of Charlotte, Queen of Great Britain, a view of the original Manor House and of the first Queen Charlotte's Hospital.

This work on *The Practice of Obstetrics* is credited to six members of the hospital staff and may be said to have fairly achieved the impossible in that it is remarkably well adapted to both the needs of students and practitioners of medicine. Its scope is well within the range of the medical student and yet it presents in detail the various subjects and in a manner that cannot fail to meet the practical everyday needs of the general practitioner.

The chapter on hæmorrhages in early pregnancy is a masterpiece and reflects the highly conservative attitude of the authors. It may not be amiss to remark that not all readers will agree with the authors in their management of the septic uterus. The following quotation is the one in question: "After the uterus has been emptied, a rubber irrigation tube should be placed in the cavity, reaching to the top of the fundus, and stitched to the cervix by a couple of catgut sutures. By means of the tube, which should be long enough to be strapped conveniently to the thigh, irrigations of the uterus are made at two hourly intervals during the day, and four hourly during the night. For their purpose Milton's fluid, 10 per cent, or eusol, or glycerine just colored by the addition of tincture of iodine is used. A glass syringe holding 4 ounces is used. Irrigation and drainage of the acutely septic uterus is the surest and quickest means of clearing up the infection and preventing the extension of the local infection into the blood stream."

In referring to the prognosis and effects of treatment in eclampsia, the authors frankly admit of difficulties. An apparent improvement may be closely followed by deterioration, and a patient desperately ill with repeated convulsions may as promptly change for the better. The results of treatment, say the authors, are most difficult to estimate. It requires a very large number of cases to justify any conclusions, so "capricious" is the disease. When, as often happens, recovery is sudden and dramatic, the remedy, whatever it may be, is given credit for the "cure." Thus we find that immediate delivery by vaginal or abdominal cæsarean section is regarded by some as the only method, while others regard all operative delivery as a source of danger, and put their trust in various forms of medical treatment. The authors observe that the mortality tends to rise in proportion to the amount of obstetrical interference.

The entire subject of obstetrics is presented in a logical well-ordered manner; the illustrations have good teaching value. The reviewer recommends this work as a text in our medical schools and as a reference book on the shelves of our practicing profession.

PROFESSOR Georg Winter, of Koenigsberg, presents a monograph on operative obstetrics for practitioners and students.[3] The work may be said to be the expression of twenty-five years of experience in the teaching of operative obstetrics, and we find the subject presented in a manner that reflects the art of the teacher. We note that the author has incorporated his contribution to the Halban-Seitz, *Biologie und Pathologie des Weibes* on "Diagnose and Behandlung der muetterlichen Verletzungen" und "Die Behandlung des Aborts"; also a chapter by Benthin on "Asepsis and Antisepsis" and "Narkose," together with a chapter contributed by Naujoks on "Diagnose und Behandlung der kindlichen Verletzungen" and a second chapter on "Die Behandlung der kindlichen Asphyxie."

[1] The History of British Midwifery from 1650 to 1800. The Fitz-Patrick lectures for 1927 delivered before the Royal College of Physicians of London. By Herbert R. Spencer, M.D., B.S. (Lond.). London: John Bale, Sons & Danielsson, Ltd., 1927.

[2] Practice of Obstetrics. By J. Bright Banister, M.D., F.A.C.S.; Aleck W. Bourne, M.B., F.R.C.S.; Trevor B. Davies, M.D., F.R.C.S.; L. Carnac Rivett, M.D., F.R.C.S.; L. G. Phillips, M.S., F.R.C.S., G.S.; Lane Roberts, M.S., F.R.C.S. New York: William Wood & Company, 1927.

[3] Lehrbuch der operativen Geburtshilfe fuer Aerzte und Studierende. By Professor Dr. Georg Winter. Berlin and Vienna: Urban and Schwarzenberg, 1927.

The pages are not burdened with introductory chapters on the preparation of the patient, operating room, and materials for operation, anæsthesia, and kindred subjects. In the opening chapters he proceeds at once with the subject in hand. It is apparent that the author is endeavoring to pass on to his readers the wealth of clinical experience which he has acquired in his years of clinical instruction and in this we believe that he has succeeded most admirably.

To emphasize the dangers of interference in the process of labor, the author finds a mortality of 0.1 per cent in natural labors as against 0.3 per cent in forceps cases, 0.4 per cent in extractions, 2.1 per cent in cæsarean sections, 0.1 per cent in manual removal of the placenta, and 0.5 per cent in craniotomies. Winter records 200 cases in which the placenta was delivered manually with 18 deaths; three of the number died from rupture of the uterus, one each from nephritis, embolism, and eclampsia, 7 from hæmorrhage and 3 from infection.

In the presence of tuberculosis of the lungs, the author would interrupt the pregnancy in all cases of active tuberculosis prior to the end of the seventh month of gestation. After the seventh month he would reserve interference for only the early cases and for those in which the operation is performed solely in the interest of the child.

Valvular disease of the heart, without loss of compensation, is not an indication for the interruption of pregnancy with the possible exception of mitral stenosis. When, however, the heart lesion is associated with a chronic nephritis or with tuberculosis, which is either acute or chronic, there exists a positive indication for the interruption of pregnancy.

"Keinen Abort zu viel und Keinen zu wenig"—no fetus shall be sacrificed unnecessarily and no mother's life shall be imperiled or her health ruined for want of the destruction of the unborn fetus.

The illustrations are abundant and splendidly executed. Such operative procedures as the vaginal cæsarean section, the application of the forceps, version and extraction, craniotomy, embryotomy and abdominal cæsarean section are graphically illustrated in the several stages of the procedures. The chapter on injuries to the newborn is unique and instructive. In it are many suggestions which are of great value in the care and management of these lesions.

THIS little work of Comyns Berkeley and George M. Dupuy[1] is unique in that it is in no sense a text on the subject but rather a well-ordered collection of illustrations accompanied by descriptive legends. Thus the anatomy and physiology, growth of the fetus, pregnancy, and labor and, finally, the treatment of the patient and her child after birth are presented in a logical order in the form of pen drawings, together with a condensed and lucid descriptive legend. There is much merit in this work of 150 pages.

THE admirable work of Heuser[2] presents the subject of radiology in gynecology, obstetrics, and urology not as a substitute, but rather as a valuable adjunct of the clinical examination and as a collaborating agent. In the field of gynecology, the limitations of air injections alone are discussed, and the advantages of the employment of lipiodal, iodopin, and similar media used in conjunction with insufflation are presented. The author advocates the utilization of lipiodol diluted to 50 per cent consistency with sterile olive oil, this affording a medium less viscid and one that requires less pressure in its introduction. To obliterate the disconcerting shadows of fæcal material and gas in the large bowel, the author gives a cathartic the day before, an enema of salt solution one hour before the examination and then injects one and one-half liters of a similar solution just before the examination. The bladder is injected to the point of moderate distention with air.

In the gravid or suspected gravid uterus, lipiodol should be used only when an actual doubt exists as to the condition and a clarity of information is necessary. The author states that so far he has seen no abortions when adequate precautions are observed. Until the fetal parts and membranes completely block the uterine canal, the patency of the tubes can be demonstrated. In advanced pregnancy, the lipiodol will not advance beyond the cervix.

The author opines that insufflation of the tubes can only demonstrate patency and it remains for lipiodol and similar media to provide the information as to caliber, position, and integrity of the tubes.

It is claimed that the fetal parts can be visualized as early as 3½ months, but the author recognizes the difficulties of the employment of radiography in obstetric cases.

The author indulges in much detail in the utilization of lipiodol in the visualization of the urinary bladder, kidney, and ureters.

The monograph is richly illustrated with skiagrams. All in all this work of Heuser is very attractive and instructive.

THE recently published work of Crossen on *Gynecology for Nurses*[3] is a most attractive production. It is beautifully illustrated and contains a wealth of information suited to the needs of the nurse. After a brief presentation of pelvic anatomy and physiology, the author proceeds with a recital of many of the gynecological diseases, and in this chapter the author has restrained himself from indulging in too much detail.

[1] AN ATLAS OF MIDWIFERY. By Comyns Berkeley, M.A., M.C., M.D. (Cantab.), F.R.C.P. (Lond.), M.R.C.S. (Eng.), and George M. Dupuy, M.D. London and New York: William Wood and Co., 1926.

[2] LA RADIOGRAPHIE EN GYNÉCOLOGIE, OBSTÉTRIQUE, ET EN UROLOGIE. By Dr. Med. Carlos Heuser, Buenos Aires, 1926.

[3] GYNECOLOGY FOR NURSES. By Harry Sturgeon Crossen, M.D., F.A.C.S. St. Louis: The C. V. Mosby Company, 1927.

The chapters on treatment, both non-operative and operative, are profusely illustrated and given to much valuable detail, as are also the chapters on preparations for gynecological examinations, preparations of supplies for operations, and preparation of patient.

The reviewer makes bold to suggest that in subsequent editions of the work we may be favored with a presentation of such subjects as amenorrhœa, hæmorrhage, leucorrhœa, sterility, and backache—their causes and the means employed by the nurse in their control.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

Ueber Technik und Effekte der Sympathikodiaphtherese (chemischen Sympathikusausscheidung) an den Keimdruesenarterien; fuer Aerzte und Biologen. An address given March 30, 1928, before the Society of German Physicians in Prague. By Dr. Karl Doppler. Berlin and Vienna: Urban & Schwarzenberg, 1928.

Lichtbiologie und Lichttherapie; eine Vortragsreihe, veranstaltet gelegentlich der Gruendungstagung der Gesellschaft fuer Lichtforschung, September, 1927, in Hamburg. Edited by Prof. Dr. Hans Meyer. Berlin and Vienna: Urban & Schwarzenberg, 1928.

The Medical Department of the United States Army in the World War. Vol. ix—Communicable and Other Diseases. Prepared under the direction of Maj. Gen. M. W. Ireland. By Lieut. Col. Joseph F. Siler, M.D., U.S. Army. Washington: U. S. Government Printing Office, 1928.

Selected Papers on Injuries and Diseases of Bone. By Sir William Ireland de C. Wheeler (Mod.), B.A., M.D. (Dub. Univ.), F.R.C.S.I., F.A.C.S. (Hon.). New York: William Wood and Company, 1928.

The Simple Goitres. By Robert McCarrison, C.I.E., M.D., D.Sc., LL.D., F.R.C.P. New York: William Wood and Company, 1928.

Chirurgische Operationslehre; ein Lehrbuch fuer Studierende und Aerzte. By Professor Dr. Otto Kleinschmidt. Berlin: Julius Springer, 1927.

Everyday Problems of the Everyday Child. By Douglas A. Thom, M.D. With an introduction by Grace Abbott. New York and London: D. Appleton and Company, 1928.

Lehrbuch der Gynaekologie. By Prof. Dr. W. Stoeckel. 2d ed. rev. Leipzig: S. Hirzel, 1928.

Ergebnisse der medizinischen Strahlenforschung (Roentgendiagnostik, Roentgen-, Radium- und Lichttherapie). Edited by H. Holfelder, H. Holthusen, O. Juengling, H. Martius. vol. iii. Leipzig: Georg Thieme, 1928.

Gonococcal Urethritis in the Male; for Practitioners. By P. S. Pelouze, M.D. Philadelphia and London: W. B. Saunders Company, 1928.

La Tuberculose Pulmonaire vue aux Rayons X. By Dr. Jacques Stephani. Paris: Payot, Paris, 1928.

Greffe Ovarienne et Action Endocrine de l'Ovaire. By Vittorio Pettinari. Paris: Gaston Doin et Cie, 1928.

Cardiopathies et Grossesse; le Rétrécissement Mitral dans ses Rapports avec l'État Puerpéral. By J. Séjourné. Paris: Gaston Doin et Cie, 1928.

L'Anesthésie Épidurale. Preface by Victor Pauchet. By Germain Laporte. Paris: G. Doin et Cie, 1928.

Diagnostik mit freiem Auge; Ektoskopie. By Dr. Eduard Weisz. With a foreword by Geh. Med.-Rat. Prof. Dr. Friedrich Kraus. 3d enlarged ed. Berlin and Vienna: Urban & Schwarzenberg, 1928.

Clinical Surgery; an introduction for junior students. By J. W. Dowden, M.B., F.R.C.S.E. Edinburgh and London: Oliver and Boyd, 1928.

Geburtshilfliche und Gynaekologische Therapie mit Einschluss der Heilmittel. By Dr. Georg Burckhard. Berlin and Vienna: Urban & Schwarzenberg, 1928.

The Mind of the Growing Child. Edited by Viscountess Erleigh. Preface by Sir James Crichton-Browne. New York and London: Oxford University Press, 1928.

Folklore of the Teeth. By Leo Kanner, M.D. New York: The Macmillan Company, 1928.

The Principles and Practice of Obstetrics. By Joseph B. DeLee, A.M., M.D. 5th ed. thoroughly rev. Philadelphia and London: W. B. Saunders Company, 1928.

The New York Academy of Medicine. Lectures on Medicine and Surgery. (First Series, 1927.) New York: Paul B. Hoeber, Inc., 1928.

Die Erkrankungen der Blutdruesen. By Prof. Dr. Wilhelm Falta. Vienna and Berlin: Julius Springer, 1928.

Ueber das Problem der Boesartigen Geschwuelste; eine experimentelle und theoretische Untersuchung. By Prof. Dr. Lothar Heidenhain. Berlin: Julius Springer, 1928.

Mutationstheorie der Geschwulst-Entstehung; Uebergang von Koerperzellen in Geschwulstzellen durch Gen-aenderung. By Dr. Med. K. H. Bauer. Berlin: Julius Springer, 1928.

CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

GEORGE D. STEWART, New York, *President* FRANKLIN H. MARTIN, Chicago, *Director-General*

BOSTON COMMITTEE ON ARRANGEMENTS

FREDERIC J. COTTON, *Chairman* CHARLES G. MIXTER, *Secretary*

JOHN D. ADAMS
NATHANIEL ALLISON
FRANKLIN G. BALCH
ALEXANDER S. BEGG
J. EMMONS BRIGGS
DAVID CHEEVER
ARTHUR L. CHUTE
J. H. CUNNINGHAM
HARVEY CUSHING
LINCOLN DAVIS
HILBERT F. DAY
G. S. DERBY
FLORENCE W. DUCKERING
A. W. DUDLEY
DAVID EDSALL
JOEL E. GOLDTHWAIT
WILLIAM P. GRAVES
ROBERT B. GREENOUGH
OTTO J. HERMAN
DANIEL F. JONES
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FRANK H. LAHEY
HALSEY LODER
FRED B. LUND
R. H. MILLER
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H. P. MOSHER
DONALD MUNRO
FRANKLIN S. NEWELL
R. B. OSGOOD
WILLIAM C. QUINBY
C. L. SCUDDER
JOSEPH L. STANTON
A. WARREN STEARNS
JAMES W. STONE
LORING T. SWAIN
HAROLD WALKER
WYMAN WHITTEMORE
HANS ZINSSER

PRELIMINARY PROGRAM FOR BOSTON CLINICAL CONGRESS

THE surgeons of Boston are planning a highly attractive program of clinics and demonstrations for the eighteenth annual Clinical Congress of the American College of Surgeons, to be held in that city, October 8–12. A preliminary program of the clinics and demonstrations is presented in the following pages. This program is to be revised and amplified during the weeks preceding the Congress so that the final program will completely represent the clinical activities of that great medical center in all departments of surgery. Clinics will begin at 2 o'clock on Monday afternoon and continue through the mornings and afternoons of the following days.

General headquarters for the Congress will be established at the Statler Hotel where the ballroom, foyer and other large rooms on the mezzanine floor have been reserved for registration and ticket bureaus, bulletin boards, exhibits, executive offices, etc. The ballroom at the Copley-Plaza Hotel will be utilized for the evening meetings, hospital conferences, and other large gatherings.

The annual hospital conference opens on Monday morning in the ballroom of the Copley-Plaza Hotel. An interesting program of papers, round table conferences, and practical demonstrations dealing with the many problems related to hospital efficiency is being prepared and will be published at an early date. A feature of the hospital conference will be a special session on Wednesday afternoon devoted to a symposium dealing with the standardization of the ophthalmological and otolaryngological departments in general hospitals. The conference is planned to interest surgeons, hospital trustees, executives and personnel generally, and an invitation is extended to all persons interested in the hospital field to attend the conference.

An interesting feature of this year's session will be a showing of the surgical films that have been produced under the supervision of and approved by the American College of Surgeons. A number of these films have already been completed and others are now in course of preparation and will be ready for their premier showing in Boston.

An application for reduced railway fares on account of the Boston session is pending, and we are assured that a rate of one and one-half the ordinary first-class one-way fare will be in effect from all points in the United States and Canada.

EVENING MEETINGS

The Executive Committee of the Congress is preparing programs for a series of evening sessions. The Presidential meeting on Monday evening will be held in Symphony Hall. At this, the first formal session of the Congress, the president-elect, Dr. Franklin H. Martin, of Chicago, will be inaugurated and deliver the annual address. On the same evening Professor Vittorio Putti, professor

of orthopedic surgery at the University of Bologna, Italy, and director of the Rizzoli Institute, will deliver the Murphy Oration in Surgery. Sessions on Tuesday, Wednesday and Thursday evenings will be held in the ballroom of the Copley-Plaza. On Wednesday evening members of the Clinical Congress will be the guests of the Boston Surgical Society at a special meeting of that society on which occasion the Bigelow medal is to be awarded.

Of special interest will be a symposium on the transplantation of ureters with papers by Drs. Charles H. Mayo, Robert C. Coffey, Arthur H. Curtis and others.

The annual convocation will be held on Friday evening in Symphony Hall, at which time the 1928 class of candidates for fellowship in the College will be received. The fellowship address is to be delivered by Dr. William J. Mayo.

A number of distinguished surgeons from abroad are to be guests at this year's Congress, among them being Sir George A. Syme, of Malvern, Australia, president of the Australasian College of Surgeons; Sir Charles P. B. Clubbe, of Sydney, Australia; Professor Archibald Young and Dr. Farquhar Macrae, of Glasgow, Scotland.

LIMITED ATTENDANCE—ADVANCE REGISTRATION

Attendance at the Boston session will be limited to a number that can be comfortably accommodated at the clinics, the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms, and laboratories in the hospitals and medical schools as to their capacity for accommodating visitors. Under this plan it will be necessary for those who wish to attend to register in advance.

Attendance at clinics and demonstrations will be controlled by means of special clinic tickets, which plan has proved an efficient means of providing for the distribution of visiting surgeons among the several clinics and insures against overcrowding, the number of tickets issued for any clinic being limited to the capacity of the room assigned to that clinic.

BOSTON HOTELS AND THEIR RATES

Since the 1922 session of the Clinical Congress in Boston, a number of new hotels have been built, including the Statler with 1300 guest rooms. Several of the older hotels have been rebuilt and enlarged so that there are now ample first-class hotel accommodations in Boston for all who wish to attend. Many of them are located within short walking-distance of the headquarters hotels.

	Minimum Rates with Bath	
	Single Room	Double Room
Beaconsfield, 1731 Beacon St.	$3.50	$5.00
Bellevue, 21 Beacon St.	4.00	7.00
Brandon Hall, 1501 Beacon St.	2.50	4.00
Braemore, 464 Commonwealth Ave.	4.00	7.00
Brunswick, Boylston and Clarendon Sts.	3.50	5.00
Buckminster, 645 Beacon St.	3.00	4.00
Canterbury, 14 Charlesgate West	4.00	5.00
Charlesgate, Charlesgate East, Marlboro and Beacon Sts.	3.00	5.00
Copley Plaza, Copley Square	4.00	7.50
Elks, 275 Tremont St.	3.50	5.00
Fensgate, 534 Beacon St.	4.00	5.00
Gralyn, 20 Charlesgate West	3.00	5.00
Kenmore, 496 Commonwealth Ave.	3.50	6.00
Lenox, Exeter and Boylston Sts.	3.50	4.50
Lincolnshire, 20 Charles St.	4.00	6.00
New Parker, Tremont and School Sts.	3.50	5.50
Puritan, 390 Commonwealth Ave.	3.50	5.00
Ritz Carlton, Arlington and Newbury Sts.	5.00	8.00
Sheraton, 91 Bay State Road	5.00	6.00
Somerset, 400 Commonwealth Ave.	3.00	5.00
Statler, Park Square at Arlington St.	3.50	5.50
Touraine, Boylston and Tremont Sts.	5.00	7.50
Vendome,* Commonwealth and Dartmouth	8.00	16.00
Victoria, Dartmouth and Commonwealth	4.00	6.00
Westminster, Copley Square	3.00	5.00

*American Plan.

REGISTRATION FEE

A registration fee of $5.00 is required of each surgeon attending the annual Clinical Congress, such fee providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon his registration at headquarters during the meeting. This card, which is nontransferable, must be presented to secure clinic tickets and admission to the evening meetings.

PRELIMINARY CLINICAL PROGRAM

GENERAL SURGERY, GYNECOLOGY, OBSTETRICS, UROLOGY, ORTHOPEDICS

MASSACHUSETTS GENERAL HOSPITAL

Monday

Orthopedic service—2. Dry clinics.
Nathaniel Allison. Tuberculosis of the knee.
P. D. Wilson. Tuberculosis of the spine.
Dr. M. N. Smith-Petersen. Tuberculosis of sacro-iliac.
R. K. Ghormley. Internal derangement of knee joint.
Nathaniel Allison and Dr. Klein. Congenital dislocation of hip.
Surgical service—2. Dry clinics.
J. H. Means, E. P. Richardson and George Holmes. The thyroid.
George McIver. Burns.
Drs. White and Sprague. The heart in surgery.
C. M. Jones. The gall bladder.
J. H. Means. Surgical cases.

Tuesday

J. D. Barney and staff—9. Genito-urinary operations.
Surgical service—11. Surgical operations.
D. F. Jones—2. Dry clinic: Cancer of gastro-intestinal tract.
C. A. Porter—2. X-ray burns.
W. J. Mixter, J. B. Ayer and J. S. Hodgson—2. Surgery of the nervous system, operations and demonstration of cases.
J. V. Meigs—2. Uterine bleeding, etc.
L. S. McKittrick—2. Radium in cancer of the rectum.
Arthur Allen and R. H. Smithwick—2. Circulatory diseases of the extremities; postoperative pulmonary infections.

Wednesday

Drs. Wyman Whittemore, Churchill and Lord—9. Thoracic surgery, operations.
R. C. Cabot and Miss Cannon—2. Social service.
Dr. Brewster—2. Surgical clinic.
Dr. Lloyd and associates—2. Syphilis and surgery.
F. A. Washburn—2. Early days of the Massachusetts General Hospital, first ether anæsthesia.
Dr. Simmons—2. Surgical cases.
William Herman—2. Psychiatry and surgery.
Dr Holmes and associates—2. Demonstration in X-ray department.

Thursday

Orthopedic service—9. Operations and demonstration of cases.
Drs. Wilson and Danforth. Arthritis of spine.
Nathaniel Allison and Dr. Coonse. Arthritis of knee.
William Rogers and Dr. Straumer. Arthritis of hip.
R. K. Ghormley and Dr. Low. Poliomyelitis.
William Rogers. End-result studies.
Fracture service—2. Demonstration of cases.
Drs. Vincent and A. V. Bock—2. Dry clinic: The spleen.
E. P. Richardson—2. Hernia through cardiac orifice of diaphragm.
Lincoln Davis—2. Cancer of cæcum; duodenum and gall bladder.
Dr. Hanford (Presbyterian Hospital, New York) and Richard Miller—2. Clinic on surgical tuberculosis.
Dr. Daland—2. Clinic on plastic surgery.
Dr. Shedden—2. Surgical clinic.

Friday

Staff—9. Surgical operations.
G. A. Leland—12. Fascia repair of hernia.
Drs. C. A. Porter, Brewster, Jones, Davis, Richardson and Williams—11. Surgical clinic.
R. B. Greenough and associates—2. Tumor clinic.
Dr. McInver—2. Gastro-intestinal surgery.
Dr. Williams—2. Gall-bladder surgery.
Dr. Aub—2. Clinic on occupational diseases; calcium metabolism in bone.
A. V. Bock—2. Surgical clinic.
Dr. Harmer—2. Surgical clinic.

PETER BENT BRIGHAM HOSPITAL

Monday

Harvey Cushing—2:30. Neurosurgical clinic.
Francis Newton—3:30. Diverticulitis.
Channing Frothingham—4. Passing of the chronic appendix.
E. S. Emery, Jr.—4:30. Study of the results of medical and surgical treatment of peptic ulcer.

Tuesday

Staff—9:30. Surgical operations.
H. A. Christian—2:30. Medical diagnostic and therapeutic clinic.
Gilbert Horrax—3:30. Cordotomy for the relief of pain.
J. P. O'Hare—4. Hypertension and nephritis in relation to surgery.
David Cheever—4:30. Surgical diagnostic clinic.

Wednesday

Staff—9:30. Surgical operations.
M. P. Sosman—2:30. X-ray study of massive atelectasis of the lung.
G. P. Grabfield—3. Effect of drugs on the nitrogen metabolism.
John Homans—3:30. Treatment of varicose ulcer.
S. A. Levine—4. Heart disease in surgery.
S. B. Wolbach—4:30. Demonstration in surgical pathology.

Thursday

Staff—9:30. Surgical operations.
W. C. Quinby—2:30. Surgical clinic.
R. H. Fitz—3. Insulin in surgical conditions.
William Murphy and John Powers—3:30. Treatment of secondary anæmia by liver diet.
Harvey Cushing and Tracy Putnam—4. Pituitary gland and its influence on growth.

CAMBRIDGE HOSPITAL

Tuesday

Staff—9. General surgical clinics, operations and demonstration of cases.

Wednesday

J. W. Sever and F. A. Findlay—9. Orthopedic clinic, operations and demonstration of cases.

Friday

Staff—9. General surgical clinics, operations and demonstration of cases.

HARVARD MEDICAL SCHOOL

Monday

DRS. GAMBLE and KEEVER—2. Acid base factors in pyloric and duodenal obstruction in children.

DRS. WOLBACH and BLACKFAN—2. Hæmatological studies with special reference to splenectomy in children.

BRONSON CROTHERS—2. Studies of injuries to the spinal cord in infants.

W. L. MOSS and DR. ELEY—2. Studies concerning blood transfusion.

LLOYD D. FELTON—2. Pneumococcus antibody solution, methods and uses.

W. LLOYD AYCOCK and E. H. LUTHER—2. Infantile paralysis: modes of spread, use of convalescent serum, experiments in immunity, and epidemiology of the disease.

M. J. ROSENAU and H. B. ANDERVENT—2. Filterable viruses, experiments on encephalitis, herpes and vaccine virus.

W. B. CANNON—2. Complete denervation of heart; effects of total sympathectomy.

ALEX. FORBES and HALLOWELL DAVIS—2. Demonstration in laboratory, electrical methods for analyzing functions of nerve tissue.

The new electro-physiology center will be open for inspection to any who are interested in the physiology of the nervous system.

Tuesday

DRS. GAMBLE and KEEVER—2. Acid base factors in pyloric and duodenal obstruction in children.

DRS. WOLBACH and BLACKFAN—2. Hæmatological studies with special reference to splenectomy in children.

BRONSON CROTHERS—2. Studies of injuries to the spinal cord in infants.

W. L. MOSS and DR. ELEY—2. Studies concerning blood transfusion.

L. W. SMITH—2. Pathology of the thyroid gland.

C. L. CONNOR—2. The behavior of certain tumors of fowls when transplanted to bone; studies in carotin, its occurrence, its preparation in pure forms, results of injection and feeding experiments.

HENRY PINKERTON—2. The behavior of oils and fats in the lungs; the pathology of the splenomegalies in childhood.

SHIELDS WARREN—2. The prevention of peritoneal adhesions by amniotic fluid, experimental and clinical results.

M. J. SCHLESINGER—2. The effects of hæmatoporphyrin on animals.

DRS. WOLBACH and HOWE—2. The pathology of the deficiency diseases, with special reference to scorbutus, rachitis and vitamin-A deficiency (xerophthalmia).

Wednesday

LLOYD D. FELTON—2. Pneumococcus antibody solution, methods and uses.

W. LLOYD AYCOCK and E. H. LUTHER. Infantile paralysis, modes of spread, the use of convalescent serum, experiments in immunity, and epidemiology of the disease.

J. W. SCHERESCHEWSKY—2. Cancer, the use of high frequency currents.

M. J. ROSENAU and H. B. ANDERVENT. Filterable viruses, experiments on encephalitis, herpes and vaccine virus.

W. B. CANNON—2. Complete denervation of the heart; effects of total sympathectomy.

ALEX. FORBES and HALLOWELL DAVIS. Demonstration in laboratory; electrical methods for analyzing the functions of nerve tissue.

PHILIP DRINKER—2. New methods of artificial respiration.

CECIL K. DRINKER and STEPHEN WENT—2. New colloid solutions for intravenous injections as substitutes for simple salt solutions.

LOUIS A. SHAW—2. Experiments on the exchange of gases through normal tissues.

STANLEY COBB—2. Microscopic demonstration of capillary injection of the brain.

H. S. FORBES—2. Demonstration of the cerebral circulation in living cats.

Thursday

L. W. SMITH—2. Pathology of the thyroid gland.

C. L. CONNOR—2. The behavior of certain tumors of fowls when transplanted to bone; studies on carotin, its occurrence, its preparation in pure form; results of injection and feeding experiments.

HENRY PINKERTON—2. The behavior of oils and fats in the lungs; the pathology of the splenomegalies in childhood.

SHIELDS WARREN—2. Prevention of peritoneal adhesions by amniotic fluid, experimental and clinical results.

M. J. SCHLESINGER—2. The effects of hæmatoporphyrin on animals.

DRS. WOLBACH and HOWE—2. The pathology of the deficiency diseases with special reference to scorbutus, rachitis and vitamin-A deficiency (xerophthalmia).

EDWIN J. COHN—2. The interaction between proteins and electrolytes, or the more special problem concerned with the nature "of the material in liver effective in pernicious anæmia."

STANLEY COBB—2. Microscopic demonstration of capillary injection of the brain.

H. S. FORBES—2. Demonstration of the cerebral circulation in living cats.

Friday

Conferences in general surgery, orthopedics, genito-urinary surgery, gynecology and obstetrics, from 9 to 12.

THORNDIKE MEMORIAL—BOSTON CITY HOSPITAL

Tuesday and Thursday, 2:30

GEORGE R. MINOT. Treatment of pernicious anæmia.

DRS. MINOT, WEARN and others. Epilepsy; capillary circulation; achylia gastrica; anæmia and disorders of the blood; cardiovascular diseases; metabolism; bacteriology.

R. P. STRONG. Demonstration of certain tumors of parasitic origin.

G. C. SHATTUCK. Lecture on tropical diseases of surgical interest.

SURGICAL LABORATORY—MASSACHUSETTS GENERAL HOSPITAL

Tuesday and Thursday, 2

M. A. MCIVER. Experimental problems in connection with intestinal obstruction.

J. C. WHITE. Subject to be announced.

R. H. SMITHWICK. Circulatory disorders of the extremities.

MASSACHUSETTS GENERAL HOSPITAL

Wednesday, 9

A. V. BOCK. Studies on the physiology of muscular work in health and disease.

J. C. AUB. Investigations in calcium metabolism bearing on bone growth and repair.

W. O. THOMPSON. Studies on thyroid disease; iodine dosage in exophthalmic goiter, thyroxin in myxœdema.

C. M. JONES. Acid and base secretions by the stomach; reference of pain from the gastro-intestinal tract.

WARREN MUSEUM

Open daily from 2 to 4 p.m.

Demonstrations by DR. M. CANAVAN, Curator

Dwight collection of spines illustrating deformities, anomalies, diseases.

Bone tumors, with X-ray, histories, and microscopic slides and microscopes available for examination. Some of these specimens were used in the illustrations in the monograph on "Bone Sarcoma" issued by the American College of Surgeons.

Models showing various types of club feet and effects of operation.

The pictures in Dr. Nichols' collection illustrating pathological conditions of bone.

Fractures and dislocations of bones as they existed before industrial plants provided so many safeguards.

Tuberculosis of bones and joints.

Syphilis of bones.

Dislocation of ends of bones.

Collection of old surgical instruments, obstetrical forceps, turn keys for extracting teeth, urological tools, cupping and leeching instruments.

CARNEY HOSPITAL

Monday

A. R. MACAUSLAND—2. Dry clinic: Traumatic injuries of the hip joint, illustrated.
H. G. LEE—2. Dry clinic: Fractures of the femoral shaft and of the table of tibia; wrist joint arthroplastics.
D. F. MAHONEY—2. Dry clinic: Radical operations for carcinoma of the breast and perforating duodenal ulcer, with presentation of cases.

Tuesday

F. B. LUND, A. MCK. FRASER and associates—9. Surgical operations.
F. W. JOHNSON, L. E. PHANEUF and associates—9. Gynecological and obstetrical operations.
A. L. BRETT—2. Dry clinic: Ununited fracture of neck of femur; bone screws in fractures; fusion of spine.
F. B. LUND, E. J. DENNING and W. E. BROWNE—2. Dry clinic: Chronic duodenal ulcer.
F. W. JOHNSON—2. Dry clinic: End-results following interposition operation for uterine prolapse (lantern slides).

Wednesday

D. F. MAHONEY, W. E. BROWNE and associates—9. General surgical operations.
F. W. JOHNSON, L. W. PHANEUF and associates—9. Gynecological and obstetrical operations.
P. N. JEPSON—2. Dry clinic: Relative value of various types of operative bone splinting, including the massive bone graft; treatment of chronic arthritis of the spine, operative and nonoperative; incidence, recognition and treatment of spondylolithesis; overcorrection of deformities in fractures.
A. MCK. FRASER—2. Dry clinic: Cæcostomy in acute appendicitis with peritonitis, presentation of cases.
L. E. PHANEUF—2. Dry clinic: The low or cervical cæsarean section (lantern slides).

Thursday

F. B. LUND, A. MCK. FRASER and associates—9. General surgical operations.
F. W. JOHNSON, L. E. PHANEUF and associates—9. Gynecological and obstetrical operations.
W. R. MACAUSLAND—2. Dry clinic: Mobilization of the knee and elbow.
M. H. BLOOMBERG—2. Dry clinic: Scoliosis and club foot
E. J. DENNING—2. Dry clinic: Postoperative medical problems; pre-operative treatment in cardiac cases.
L. E. PHANEUF—2. Dry clinic: Uterine bleeding (lantern slides).

Friday

D. F. MAHONEY, W. E. BROWNE and associates—9. General surgical operations.
F. W. JOHNSON, L. E. PHANEUF and associates—9. Gynecological and obstetrical operations.
A. SARGENT and B. A. GODVIN—2. Orthopedic clinic.
E. J. DENNING—2. Dry clinic: Intestinal parasites in immigrants.
W. E. BROWNE—2. Dry clinic: Fractures and injuries of the hand and forearm with presentation of special splints.
L. E. PHANEUF—2. Dry clinic: Appendicitis and pregnancy.

LONG ISLAND HOSPITAL

Monday

J. H. CUNNINGHAM and C. S. SWAN—2. Genito-urinary clinic, operations and demonstration of cases.
LAWRENCE W. SMITH—2. Pathological demonstration.
HENRY VIETS—2. Neurosurgical cases.
A. B. MACMILLAN—2. X-ray demonstration.

Wednesday

ROBERT SOUTTER—2. Orthopedic clinic, operations and demonstration of cases; traction in the treatment of fractures; treatment of congenital hip.
LAWRENCE SMITH—2. Pathological demonstration.
HENRY VIETS—2. Neurosurgical cases.
A. B. MACMILLAN—2. X-ray demonstration.
CHARLES LUND—2. Injection treatment of varicose veins; operations and demonstration of cases.

Friday

J. H. CUNNINGHAM and C. S. SWAN—2. Genito-urinary operations.
ROBERT SOUTTER—2. Orthopedic operations.
CHARLES LUND—2. General surgical operations.
LAWRENCE SMITH—2. Pathological demonstration.
HENRY VIETS—2. Neurosurgical cases.
A. B. MACMILLAN—2. X-ray demonstration.

CLINICS ON INDUSTRIAL SURGERY

At these clinics, to be held in the office of the Medical Director of the American Mutual Liability Insurance Company, cases will be shown to illustrate diagnosis, treatment and end-results.

Tuesday

ERNEST A. CODMAN—2. Shoulder injuries.
EDWARD L. YOUNG—4. Inguinal pain without hernia.

Wednesday

P. D. WILSON—2. Fractures of the os calcis; injuries to the knee.
RUDOLPH JACOBY—4. Industrial dermatology.

Thursday

FRED J. COTTON—2. Reconstruction surgery in industry.
JOHN D. ADAMS—4. Injuries to the back.

Friday

JOHN D. HODGSON—2. Fractures of the skull.
HARRY C. SOLOMON—3. Industrial neurology.
HENRY C. MARBLE—4. Hernia.

BOSTON CITY HOSPITAL

Monday

N. R. Mason, R. M. Green, G. T. Williams, F. L. Good, J. P. Cohen, H. V. Hyde and F. J. Lynch—2. Gynecological and obstetrical clinic, operations and demonstration of cases.

Tuesday

H. Binney, A. R. Kimpton, H. H. Howard, G. W. Papen, D. D. Scannell, S. Fraser, J. J. Hepburn and T. W. Wickham—9. Surgical clinic, operations and demonstration of cases.

Surgical Services I and III—2. Dry clinic.

F. W. White—2. Intussusception of the bowel occurring within the stomach following gastro-enterostomy.

G. C. Shattuck—2. Surgical aspects of some tropical maladies.

Wednesday

H. B. Loder, J. J. Walker, F. F. Henderson, E. Harding, J. C. Hubbard, R. C. Cochrane, D. Munro, A. Riley and T. Richards—9. Surgical clinic, operations and demonstration of cases.

Surgical Services II and V—2. Dry clinic.

G. R. Minot and J. T. Wearn—2. Dry clinic.

W. R. Ohler—2. The care of the surgical diabetic.

F. B. Mallory—2. Pathological demonstration.

Thursday

F. J. Cotton, O. J. Herman, J. H. Shortall and W. Morrison—9. Surgical clinic, operations and demonstration of cases.

D. Munro and Tracy Putnam—9. Neurosurgical operations.

Surgical Service IV—2. Dry clinic: Neurosurgical cases.

S. Cobb and A. Myerson—2. Neurological clinic.

B. Butler—2. X-ray demonstration.

Friday

F. B. Mallory, P. F. Butler, F. J. Cotton, R. W. Andrews and others—9. Conferences and presentation of special subjects.

ST. ELIZABETH'S HOSPITAL

Tuesday

G. F. Keenan—9. Surgical clinic; Appendectomy; hysterectomy.

Joseph Stanton—9. Surgical clinic: Thyroid cases; gastro-enterostomy.

W. F. Dolan—9. Surgical clinic: Inguinal hernia.

C. J. Kickham—9. Prolapse of uterus.

F. T. Jantzen—9. Inguinal hernia under local anæsthesia.

H. S. Rowen—9. Appendectomy.

A. L. Chute and B. D. Wetherell—2. Dry clinic: Genito-urinary cases, end results and unusual roentgenograms.

T. J. Scanlan—2. Gynecological examinations.

Pierce Dunphy—2. Cases of cancer of cervix; operation and X-ray therapy, one to four years after operation.

Pierce McGann—2. Postoperative hypospadias.

Wednesday

F. T. Jantzen—9. Surgical clinic: Appendectomy; cholecystectomy.

G. F. Keenan—9. Surgical clinic: Cholecystectomy.

Pierce Dunphy—9. Perineal plastic; cæsarean section.

Joseph Stanton—9. Thyroid cases.

R. Sullivan—9. Knee cartilage.

T. F. Broderick—9. Reconstruction of hip; plastic on knee joint.

T. F. Broderick and R. F. Sullivan—2. Dry clinic: End results in spinal fusion for tuberculosis, scoliosis, and anatomical anomalies; end results in plastic cases for relief of deformity.

F. T. Jantzen—2. End results in fractures, operative and non-operative; colloidal lead treatment for malignant diseases.

Dr. Healey—2. Interesting roentgenograms.

John Dunphy—2. Surgical aspects of pediatrics.

Thursday

T. F. Broderick—9. Surgical clinic: Spinal fusion.

A. L. Chute—9. Prostatectomy; tumor of bladder; nephrectomy.

Joseph Stanton—9. Gastro-enterostomy; cholecystectomy; appendectomy.

H. S. Rowen—9. Hysterectomy.

G. F. Keenan—9. Ovarian cyst.

A. H. Crosbie—9. Nephrectomy.

Joseph Stanton—2. Dry clinic: Hour-glass stomach; fibroma of colon, with intermittent intussusception; carcinoma of appendix.

J. J. Sullivan—2. Toxæmia following administration of alkalies for treatment of duodenal ulcer.

L. J. Louis—2. Postoperative pancreatic cyst.

H. S. Rowen—2. Surgical cases.

Friday

L. J. Louis—9. Surgical clinic: Appendectomy; cholecystectomy.

H. S. Rowen—9. Cholecystectomy.

Joseph Stanton—9. Appendectomy; hysterectomy.

G. F. Keenan—9. Ventral hernia; appendectomy.

C. J. Kickham—9. Cæsarean section.

F. T. Jantzen—9. Inguinal hernia under local anæsthesia.

G. F. Keenan—2. Dry clinic: Postoperative fracture of skull; postoperative extensive resection of chest.

M. H. Spellman—2. End results in fractures of skull.

FREE HOSPITAL FOR WOMEN

Monday

Dry clinic—2. Discussion of new problems in gynecology.

Tuesday

Operative clinic—9. Amputation of cervix and cœliotomy, first stage of procidentia; perineorrhaphy, second stage of procidentia; hysterectomy for fibroids; dilatation and curettage, cœliotomy for retroversion.

Wednesday

Operative clinic—9. Plastic and cœliotomy, reconstruction operation; hysterectomy for fibroids; dilatation and curettage, cœliotomy for retroversion; perineorrhaphy for complete laceration of perineum.

Thursday

Operative clinic—9. Amputation of cervix and cœliotomy for procidentia; plastic and cœliotomy for prolapse; hysterectomy for fibroid; closure of vesicovaginal fistula.

Friday

Operative clinic—9. Hysterectomy for cancer; dilatation and curettage and application of radium for cancer.

Dry clinic—9. Demonstration of cancer cases treated.

HUNTINGTON MEMORIAL HOSPITAL

Wednesday—2, Dry clinics

E. M. DALAND and G. W. TAYLOR. Carcinoma of the skin.
C. C. SIMMONS and C. C. LUND. Cancer of the tongue and buccal mucosa.
G. A. LELAND and J. V. MEIGS. Carcinoma of the cervix.
R. B. GREENOUGH and C. C. SIMMONS. Varying degrees of malignancy in cancer.
WILLIAM M. SHEDDON and E. P. HAYDEN. Cancer of the rectum.
E. M. HERMAN and H. V. KAZANJIAN. Cancer of the antrum and accessory sinuses.

Thursday—2, Dry clinics

WILLIAM DUANE and J. C. HUDSON. The modern X-ray plant.
E. M. DALAND and WILLIAM M. SHEDDON. Cancer of the lip.
G. G. SMITH. Carcinoma of the genito-urinary tract.
R. B. GREENOUGH and C. C. SIMMONS. Carcinoma of the breast.
C. C. SIMMONS. Malignant bone tumors.
E. M. DALAND and C. C. LUND. Electrocoagulation in the treatment of malignant disease.

CHILDREN'S HOSPITAL

Monday

A. H. FREIBERG and H. J. FITZSIMMONS—2. Torticollis, conference followed by operation.
F. DICKSON and R. SOUTTER—2. Congenital dislocation of hip, conference followed by closed reduction and shelf operation.

Tuesday

Staff—9. General surgical operations, followed by dry clinic.
WILLIAM LADD. Hare lip and cleft palate.
C. G. MIXTER. Contractures and plastics.
H. W. HUDSON. Angiomata.
G. D. CUTLER and KENNETH BLACKFAN. Empyema and lung abscess, medical aspects.
Staff—2. Orthopedic clinic, infantile paralysis.
WILLIAM L. AYCOCK and E. H. LUTHER. Epidemiology; occurrence; serum treatment.
S. M. FITCHET. Demonstration of apparatus for prevention of deformity in early cases.
MISS MERRILL. Muscle training.
DR. STEINDLER and FRANK OBER. Tendon transplantations.
DRS. RYERSON, HOKE and A. T. LEGG. Stabilizing operations.
A. T. LEGG and FRANK OBER. Operations.

Wednesday

W. E. LADD, R. B. OSGOOD and associates—9. Clinic by combined surgical and orthopedic services: Present policies in the treatment of glandular, intra-abdominal, bone and joint tuberculosis.
R. B. OSGOOD, W. E. LADD and associates—2. Combined clinic of surgical and orthopedic services: Osteomyelitis—acute, chronic, circumscribed; Brodie's abscess; septic joints; types of infection and treatment.

Thursday

Staff—9. Orthopedic clinic.
A. TAYLOR and J. W. SEVER. Obstetrical paralysis, demonstration of cases (lantern slides and moving pictures).
DRS. VON LACKUM, CANNON, M. N. FULTON and G. W. W. BREWSTER. Spastic palsy.
BRONSON CROTHERS and MISS TRAINOR. Muscle training.
G. W. W. BREWSTER. Operation (Stoeffel).
Staff—2. General surgical clinic, operations and dry clinic.
C. G. MIXTER. Urinary obstruction and infection.
WILLIAM LADD. Kidney stone.
THOMAS LANMAN. Hernia and undescended testicle.
C. G. MIXTER and S. B. WOLBACH. Kidney tumors, pathological aspects.

Friday

Staff—9. General surgical clinic, operations and dry clinic.
WILLIAM LADD. Pyloric stenosis.
G. D. CUTLER. Idiopathic peritonitis.
AUGUSTUS THORNDIKE. Appendicitis.
C. G. MIXTER. Intussusception.
WILLIAM LADD. Obliteration of bile ducts.
Staff—2. Orthopedic clinic.
F. A. PEMBERTON and R. B. OSGOOD. Chronic arthritis, demonstration of cases.
DR. KLEINBERG and G. W. W. BREWSTER. Scoliosis, demonstration of apparatus and treatment.

BOSTON DISPENSARY

Tuesday

JOHN D. ADAMS—2. Orthopedic operations.
H. J. INGLIS—2. Lipiodol injections.
MAYNARD LADD—2. Postoperative findings in pyloric stenosis.

Thursday

H. F. DAY—2. Injection treatment of varicose veins with demonstration of technique, cases and pathological specimens.
DAVID DAVIS and H. F. DAY—2. Gastro-enteric diagnoses, demonstration of cases and methods.
JOSEPH PRATT—2. Importance of the physician to the surgeon.

NEW ENGLAND HOSPITAL FOR WOMEN AND CHILDREN

Tuesday

Staff—9. General surgical operations.
Staff—9. Obstetrical clinic, cæsarean sections and operative deliveries; prenatal clinic.

Wednesday

Staff—9. General surgical operations; nursery and ward walks with demonstration of unusual cases; prenatal clinic.

Thursday

Staff—9. Demonstration of postoperative cases with pathological specimens and roentgenograms; borderline cases; prenatal clinic.

BETH ISRAEL HOSPITAL

WYMAN WHITTEMORE and associates—9, daily. General surgical clinic.
E. G. CRABTREE—9, daily. Urological clinic.
MARK ROGERS—9, daily. Orthopedic clinic.
HERMAN BLUMGARD. Demonstration in medical research department.

TUFTS COLLEGE MEDICAL SCHOOL

TIMOTHY LEARY—2, daily. Demonstration of specimens illustrating results of traumatism, especially cranial and cerebral.

MASSACHUSETTS HOMEOPATHIC HOSPITAL

Monday

T. E. Chandler and H. J. Lee—2. General surgical clinic: Operations and demonstration of cases.

Tuesday

C. T. Howard and C. Crane—9. Surgical operations.
R. C. Wiggin and S. N. Vose—9. Urological operations.
S. W. Ellsworth—10. X-ray demonstration.
S. R. Meaker—10. Gynecological clinic.
J. E. Briggs and W. K. S. Thomas—2. General surgical operations.

Wednesday

T. E. Chandler and C. D. Harvey—9. Surgical operations.
A. G. Howard, S. L. Marnoy and L. G. Howard—9. Orthopedic operations.
C. T. Howard and H. J. Lee—2. Surgical operations.
L. F. Johnson—2. Bronchoscopic clinic.

Thursday

J. E. Briggs and C. Crane—9. Surgical operations.
S. R. Meaker—10. Gynecological clinic.
S. W. Ellsworth—10. X-ray demonstration.
C. T. Howard and W. K. S. Thomas—2. Surgical operations.

Friday

T. E. Chandler and C. Crane—9. Surgical operations.
J. E. Briggs and H. J. Lee—2. Surgical operations.

BOSTON LYING-IN HOSPITAL

Tuesday

Staff—9. Dry clinics.
B. E. Hamilton. Heart disease in pregnancy.
F. S. Newell. Treatment of pregnancy complicated by heart disease.
S. Berman. End results in pre-eclamptic toxæmia.
F. C. Irving. Treatment of pre-eclamptic toxæmia by the removal of blood plasma and the reinfusion of corpuscles.
E. G. Crabtree. Clinical aspects of pyelitis in pregnancy.
G. C. Prather. The postpartum bladder.

Wednesday

Staff—9. Obstetrical operations.

ROBERT BRIGHAM HOSPITAL

Tuesday

H. A. Nissen—2. Focal infection in chronic arthritis; gastro-intestinal studies.
H. T. Swaim—3. Types of arthritis with X-ray studies and orthopedic principles in the treatment.

Wednesday

P. D. Wilson—2. Operation for knee deformities.
H. T. Swaim—3. Demonstration of orthopedic apparatus.

Thursday

L. M. Spear—2. Circulatory conditions in arthritis.
L. T. Brown—3. Mechanical conditions of the low back.

Friday

P. D. Wilson—2. Orthopedic operations and demonstration of cases; orthopedic principles in the treatment of chronic arthritis.

NEW ENGLAND BAPTIST HOSPITAL

Tuesday

E. L. Young, Jr., D. L. Jackson, H. B. Loder and D. J. Bristol, Jr.—9. General surgical clinic, operations and demonstration of cases.

Wednesday

F. H. Lahey and H. M. Clute—9. Surgical operations.
Sara M. Jordan and E. Kiefer—2. Gastro-enterological clinic.

Thursday

E. L. Young, Jr., D. L. Jackson, H. B. Loder and D. J. Bristol, Jr.—9. General surgical clinic: operations and demonstration of cases.

NEW ENGLAND DEACONESS HOSPITAL

D. F. Jones, Frank H. Lahey, A. M. Chute and Leland McKittrick—9, daily. General surgical clinic: Operations and demonstration of cases.
Staff—2, daily. Dry clinic: Surgery of diabetics; diabetes and thyroidism; gastric and duodenal ulcer.

BOSTON UNIVERSITY SCHOOL OF MEDICINE

(Evans Memorial Building)

S. R. Meaker and A. W. Rowe—2, Wednesday and Friday. Studies in sterility.
A. W. Rowe and C. H. Lawrence—2, Wednesday and Friday. Endocrinology.

SURGERY OF THE EYE, EAR, NOSE AND THROAT

MASSACHUSETTS EYE AND EAR INFIRMARY

Tuesday

Otolaryngology

PHILIP HAMMOND—9. Simple and radical mastoid operation.
H. A. BARNES—9. Malignant diseases of the accessory sinuses.
H. P. CAHILL—10. Dry clinic: Wire gauze brain drain; paraffin basket for skin graft of radical mastoid cavity; lantern slides of brain cases.
G. H. TOBEY—11. Dry clinic: Lateral sinus thrombosis; the manometer test.
C. B. FAUNCE—2. Lipiodol injections in brain abscess.
D. C. SMYTH—3. Lipiodol injections in lung abscess.

Ophthalmology

G. S. DERBY—9. Surgery of the eye.
F. H. VERHOEFF. Pathology of the eye.
W. B. LANCASTER. Muscles.
J. H. WAITE. Slit lamp demonstration.
H. B. C. RIEMER. Tear sac operation.
E. B. DUNPHY. Perimetry.
T. L. TERRY. Pathology of the eye.
W. H. LOWELL. Muscles.
H. B. CHANDLER. Tear sac operation.
Staff—2. Dry clinic; ward rounds, demonstration of cases.

Wednesday

Ophthalmology

DR. WHEELER—9. Surgery of the eye.
DR. HOLLOWAY. Thyroid cases.
G. S. DERBY. Postoperative complications.
F. H. VERHOEFF. Interpretation of fundi.
A. F. MCMILLAN. Foreign body plus X-ray.
R. C. CHENEY. Perimetry.
Symposium—2. Failures in ophthalmology.

Otolaryngology

G. H. POIRIER—9. Mosher-Toti lachrymal sac operation.
F. A. SIMMONS—10. Tonsillectomy cases, dissection and snare.
G. H. POIRIER. Sluder technique.
H. P. CAHILL. LaForce technique.
P. E. MELTZER. Removal with cautery snare.
A. S. MACMILLAN—11. Dry clinic: Demonstration of accessory sinus and mastoid X-rays.
D. H. WALKER—2. Dry clinic: Lip reading and the deaf child.
L. A. SCHALL—3. Dry clinic: Pathology of chronic maxillary sinusitis; projection of microscopic slides.

Thursday

Otolaryngology

V. H. KAZANJIAN—9. Plastic operations.
D. C. SMYTH—9. Dry clinic: Fluoroscope and removal of metallic foreign bodies.
H. P. MOSHER—10. Exhibition of œsophageal instruments; demonstration of fluoroscopic examination of the œsophagus.
A. S. MACMILLAN—11. Lantern slide demonstration of œsophageal cases.
DR. KIRBY—2. Demonstration of Baranay tests.
F. E. GARLAND—3. Infection of the submaxillary gland.

Ophthalmology

ALLEN GREENWOOD—9. Surgery of the eye.
G. S. DERBY. Eye plus internist.
F. H. VERHOEFF. External diseases.
L. M. CARVILL. Tuberculosis of the eye.
J. H. WAITE. Demonstration of Gullstrand lamp.
H. B. CHANDLER. Perimetry.
G. S. DERBY and CHENEY—10. Eye plus internist.
G. S. DERBY—11. Light sense.
H. B. C. RIEMER. External diseases.
F. H. VERHOEFF—2. Pathological demonstration (lantern slides).
DR. HOLLOWAY. Eye and intracranial conditions.

Friday

Otolaryngology

V. H. KAZANJIAN—9. Correction of deformities of the face and nose, lantern slide demonstration.
H. P. MOSHER—10. Punch tracheotomy.
A. S. MACMILLAN. X-ray of thymus (lantern slides).
F. E. GARLAND—11. Historical exhibit of laryngeal instruments.
H. P. CAHILL—2. Lantern slide demonstration of serial sections of the ear.
D. H. WALKER—3. Lip reading and the deaf child.

Ophthalmology

F. H. VERHOEFF—9. Surgery of the eye.
G. S. DERBY and AYER. Nerves of the eye.
DR. SMITH. Social work.
J. H. WAITE. Uveitis.
H. B. C. RIEMER. Trachoma.
B. SACHS. Perimetry.
G. S. DERBY—10. Preventive ophthalmology.
Staff—2. Dry clinic: Chronic simple glaucoma and secondary glaucoma; diagnosis, significance and importance of various signs; significance of glaucoma as a cause of loss of vision and the remedy; choice of operation; treatment of secondary glaucoma.

CARNEY HOSPITAL

Tuesday

W. S. LIEBMAN—9. Eye operations and demonstration of cases; X-ray localization and magnet extraction of foreign bodies.

Wednesday

E. D. HURLEY and W. S. LIEBMAN—9. Eye operations and demonstration of cases.

Thursday

W. S. LIEBMAN and H. BORNCHOFF—9. Eye operations and demonstration of cases.

Friday

W. J. SHEEHAN and F. G. MINITER—2. Otolaryngological clinic.

BETH ISRAEL HOSPITAL

L. V. FRIEDMAN and L. ARKIN—9, daily. Nose and throat clinic.

CAMBRIDGE HOSPITAL

N. S. BACON and E. J. BUTLER—9, Thursday. Nose and throat clinic.

HARVARD MEDICAL SCHOOL

Monday

H. P. MOSHER—2. Laryngological demonstration: Casts of the adult œsophagus; wet specimens showing the œsophagus at birth; cadaver of the Mosher-Toti lachrymal sac operation; teaching methods used in post-graduate instruction in laryngology.

Tuesday

G. S. DERBY—2. Ophthalmological demonstrations: Active research, demonstrations of what the pathological laboratory is doing and has done in the past; demonstration of work on the light sense; teaching of physiologic optics.

DRS. VERHOEFF and TERRY. Demonstration of pathological slides.

DRS. DERBY, CHANDLER and MISS O'BRIEN. Significance of the light sense, and a demonstration of the methods by which it may be tested.

LUCIEN HOWE—2. Ophthalmic ergograph, writes automatically the story of ocular fatigue and relation of this fatigue to "eye strain."

H. P. MOSHER—2. Mosher-Toti lachrymal sac operation; demonstation on cadaver.

P. E. MELTZER. Anatomical exhibit of temporal bone specimens.

Wednesday

H. P. MOSHER—2. Laryngological demonstration: Casts of the adult œsophagus; wet specimens showing the œsophagus at birth; cadaver of the Mosher-Toti lachrymal sac operation; teaching methods used in post-graduate instruction in laryngology.

C. B. FAUNCE—2. Exhibition of temporal bone specimens.

Thursday

G. S. DERBY—2. Ophthalmological demonstrations: Active research, demonstrations of what the pathological laboratory is doing and has done in the past; demonstration of work on the light sense; teaching of physiologic optics.

DRS. VERHOEFF and TERRY. Demonstration of pathological slides.

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LUCIEN HOWE—2. Ophthalmic ergograph, writes automatically the story of ocular fatigue and relation of this fatigue to "eye strain."

H. P. MOSHER—2. Demonstration of methods in post-graduate teaching of laryngology.

O. R. LOURIE—3. Exhibition of temporal bone specimens.

Friday

Conferences in otolaryngology and ophthalmology from 9 to 12.

NEW ENGLAND HOSPITAL FOR WOMEN AND CHILDREN

Tuesday

Staff—9. Nose and throat clinic, operations and demonstration of cases.

Wednesday

Staff—9. Nose and throat clinic, operations and demonstration of cases.

Thursday

Staff—9. Nose and throat clinic, postoperative cases dental and antrum infections, roentgenograms, etc

ST. ELIZABETH'S HOSPITAL

Tuesday

W. T. HALEY—9. Mastoid and tonsil cases.

Wednesday

P. S. MCADAMS—9. Enucleation of the eye.

J. BURNS—9. Tonsillectomy.

Friday

W. T. HALEY—9. Frontal sinus operation.

J. BURNS—9. Mastoid operation.

W. T. HALEY—2. End-results in radical sinus operations.

MASSACHUSETTS HOMEOPATHIC HOSPITAL

Tuesday

W. D. ROWLAND—9. Eye clinic.

F. W. COLBURN and H. L. BABCOCK—9. Aural clinic.

Thursday

W. D. ROWLAND—9. Eye clinic.

C. SMITH, C. W. BUSH, E. R. JOHNSON, R. O. PARRIS and W. W. WALKER—9. Nose and throat clinic.

Friday

W. D. ROWLAND, J. E. STERNBERG, H. M. EMMONS and J. J. SKIRBALL—9. Eye clinic.

BOSTON CITY HOSPITAL

J. J. CORBETT—9, daily. Eye clinic.

BOSTON DISPENSARY

J. G. SKIRBALL—9, daily. Eye clinic: Operations; external diseases (perimetry); lues plus eye.

CARNEY HOSPITAL

E. D. HURLEY—9, daily. Eye clinic.

FIG. 3

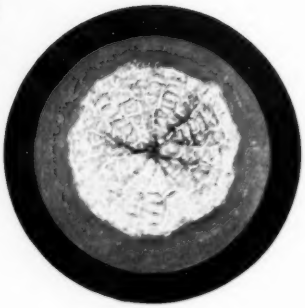

FIG. 1

FIG. 2

Fig. 1. D. G., Case 1. Showing area of leucoplakia in the urethra. The drawing was made through the air endoscope.

Fig. 2. H. S., Case 12. Note the large plaque of leucoplakia. Two small stones are visible.

Fig. 3. F. B., Case 13. Note the extensive leucoplakia formation involving the entire kidney pelvis and ureter.

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